THE PIERCE-ARROW

THE CAR AND THE REASON

COMPLIMENTS OF THE
PIERCE-ARROW MOTOR CAR CO.
BUFFALO, N.Y.

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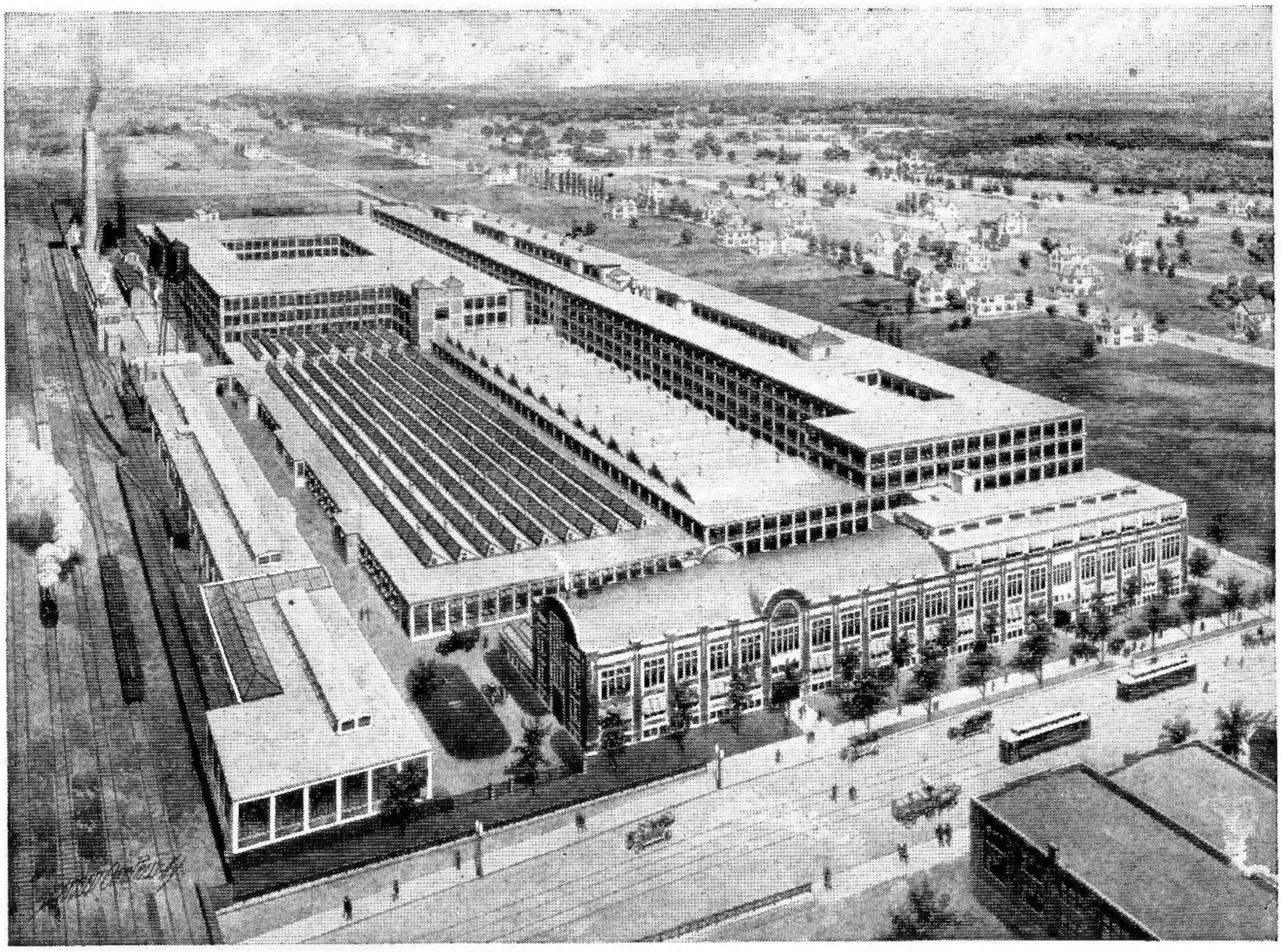


THE FACTORY BEHIND THE CAR

©

THE PIERCE-ARROW
THE CAR AND THE REASON

EVERY MAN WHO HAS BEEN CONNECTED, FOR ANY LENGTH OF TIME, WITH THE PIERCE-ARROW MOTOR CAR COMPANY IS A FIRM AND ENTHUSIASTIC BELIEVER IN THE BALANCED EXCELLENCE OF THE CARS IT BUILDS. THESE MEN KNOW THE INNER WORKINGS OF AN ORGANIZATION THAT HAS BEEN DEVELOPED DURING OVER TWENTY YEARS AND WHOSE IDEAL HAS ALWAYS BEEN TO BUILD THE BEST POSSIBLE PRODUCT, WHETHER BIRD-CAGE, REFRIGERATOR, BICYCLE, OR MOTOR CAR ⚜ THIS FAITH IN THE PIERCE-ARROW ORGANIZATION AND PRODUCT WE KNOW TO BE SHARED BY MANY HUNDREDS OF PIERCE-ARROW OWNERS. WE FEEL, HOWEVER, THAT A STATEMENT OF OUR IDEALS, AND THE METHODS AND REASONING INVOLVED IN SEEKING TO ATTAIN THESE IDEALS, MAY SERVE TO ADD TO THE RANKS OF THE FAITHFUL MANY OF THOSE WHO HAVE NOT HAD THE OPPORTUNITY TO BECOME ACQUAINTED WITH THE INNER WORKINGS OF THE ADMINISTRATIVE, DESIGNING, AND MANUFACTURING DEPARTMENTS OF OUR ORGANIZATION ⚜ IT IS FOR THIS REASON THAT THIS LITTLE BOOK IS WRITTEN

THE PIERCE-ARROW
MOTOR CAR COMPANY

BUFFALO, N. Y., U. S. A.

INDEX

UNITY OF INTEREST.

THE OWNERS, THE BOARD OF DIRECTORS, AND THE EXECUTIVE OFFICERS OF THE PIERCE-ARROW MOTOR CAR COMPANY ARE ONE AND THE SAME GROUP OF MEN.

The significance of this statement should be enormous to all users of the Pierce-Arrow product.

It means that the Pierce-Arrow organization is one of united individuality, hampered by no outside interference or syndicated control. It means that the Pierce-Arrow directors are free to utilize their full resources of capital, brains, and energy to the attainment of their ideal — the successful building and marketing of the best possible motor trucks and pleasure cars.

The Pierce-Arrow Motor Car Company builds nothing but motor cars. It is directly, or indirectly, interested in no other manufacturing enterprises. Its eggs are not in a number of baskets, nor is it one egg of many in the baskets of a group of capitalists. It is both eggs and basket.

Its whole surplus is available to substantiate its credit, to back its promises, to insure its stability, and to help improve its product.

EVERY INDIVIDUAL, DIRECTLY INTERESTED IN PIERCE-ARROW FINANCIAL SUCCESS, IS A WORKING UNIT IN THE PIERCE-ARROW ORGANIZATION.

The following is a list of the owners of the Pierce-Arrow Motor Car Company:

George K. Birge, President and member of the Board of Directors. Mr. Birge was a member of the Board of Directors of the George N. Pierce Company, and has been connected with the organization since 1896.

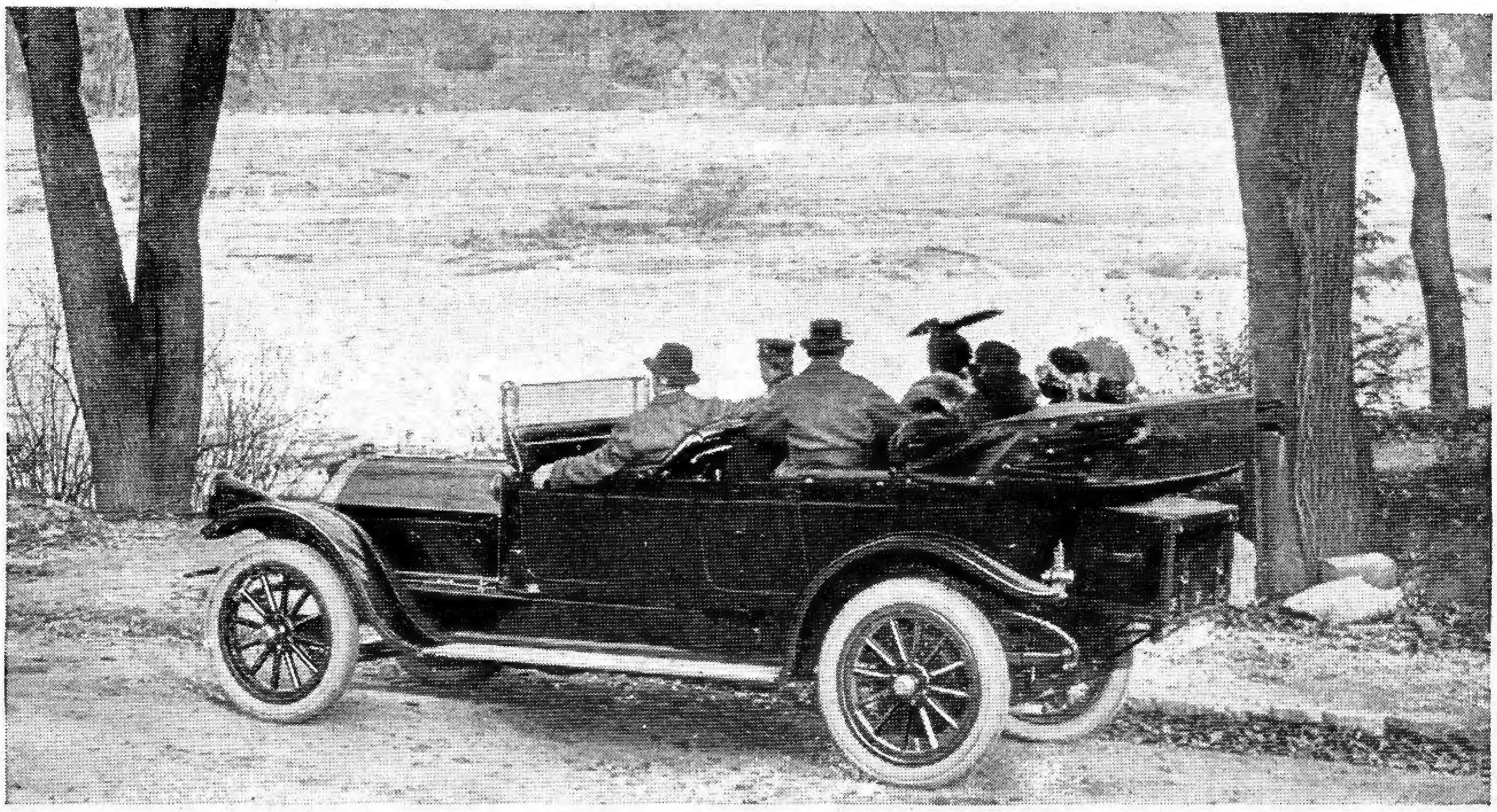
Henry May, Vice-President and member of the Board of Directors. He was Vice-President and member of the Board of Directors of the George N. Pierce Company, and has been connected with the organization since 1873.

Charles Clifton, Treasurer and member of the Board of Directors, which positions he filled in the George N. Pierce Company. He has been connected with the organization since 1897.

William H. Gardner, member of the Board of Directors. He became a member of the Board of Directors of the George N. Pierce Company in 1896, and has been connected with the organization since that year.

William B. Hoyt, legal adviser and member of the Board of Directors. Legal adviser to the George N. Pierce Company. Connected with the organization since 1896.

Lawrence H. Gardner, Secretary. Also Secretary of the George N. Pierce Company, having been connected with the organization since 1896.



THE PIERCE-ARROW WAY

There are two ways to design and build a motor car. One way is to fix the selling price in advance and then try to build as good a car as can be profitably marketed at that price. The other way is to try to design just as good a car as is possible, find out what it will cost to build and market such a car, add a reasonable profit, and fix the selling price accordingly. That is the Pierce-Arrow way.

We are not trying to build a cheap car, nor a middle-price car, nor yet a high-price car.

We are trying to build a completely efficient car.

Complete general efficiency in a motor car means power, smoothly and silently applied, and enough of it to meet all conditions of road surface, speed range, and full-capacity load. It means comfort and convenience for the passengers and driver under all weather and road conditions. It means beauty of line, color, appointments, and finish. It means that all these qualities must last. It means durability.

Durability means slow depreciation. We do not know how long a Pierce-Arrow Car, properly handled, will last. None of them have ever worn out.

General efficiency and durability depend upon good design.

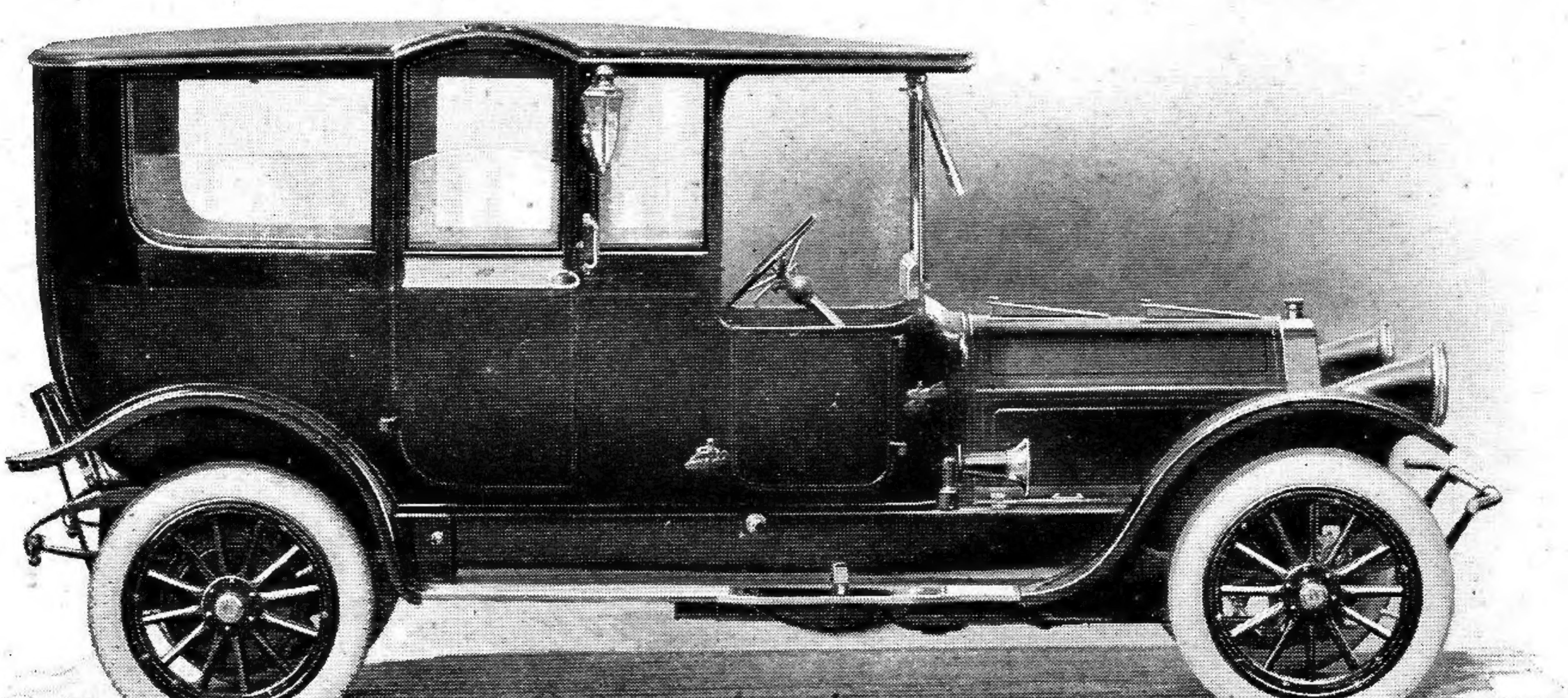
A car built for speed alone will be faster than a car built solely for load-carrying ability. If extreme efficiency in one element of performance is sought, extreme design is essential to the attainment of such a performance. A well-balanced general performance calls for a well-balanced design. In a well-balanced design no one element is sacrificed to another. Safety, power, good application of that power, comfort, convenience, and beauty, together with dependability and durability, each one developed to a point of maximum attain-

ment, constitute a well-balanced, harmonious whole. For these reasons, our design is extreme in no direction.

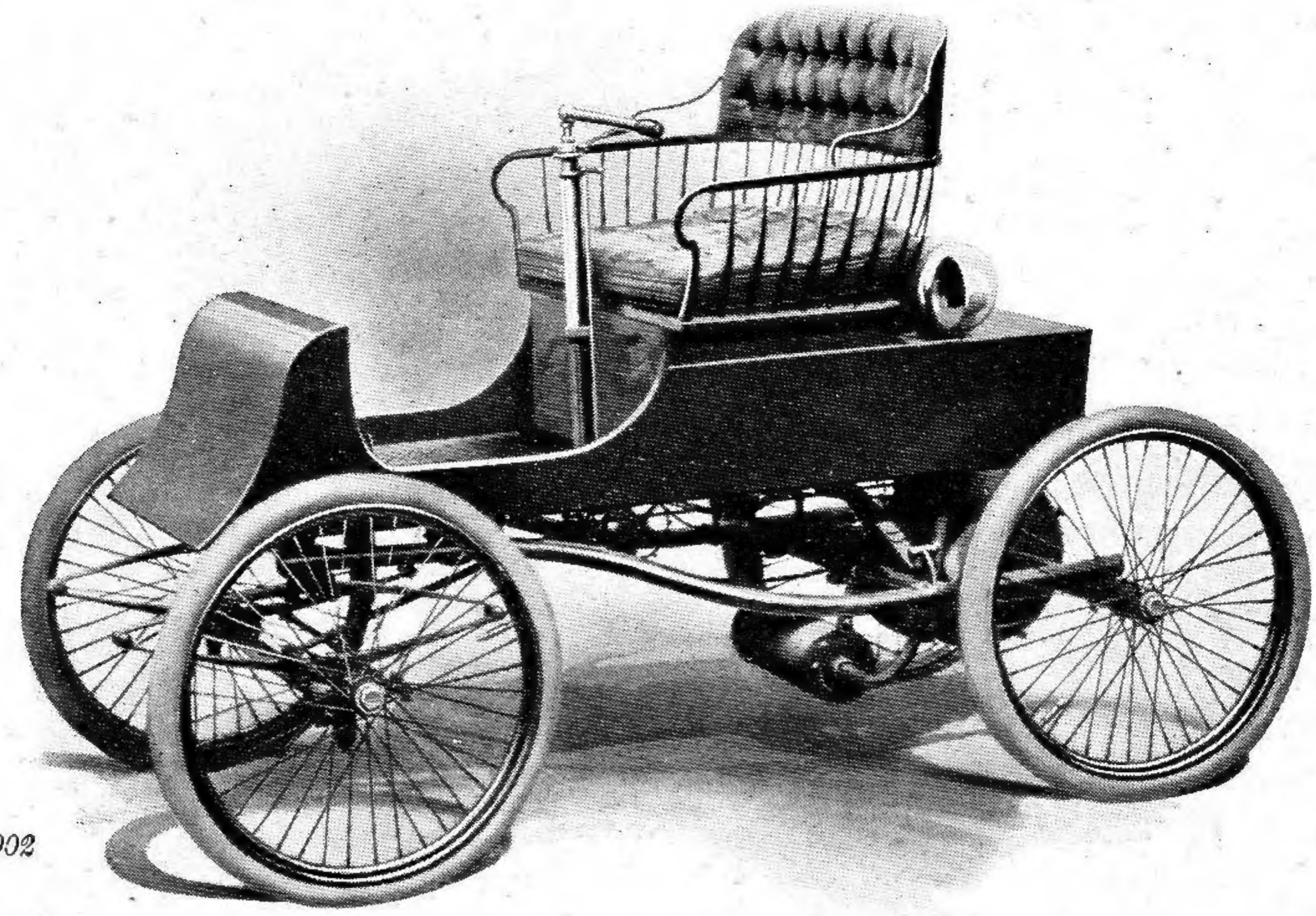
Good manufacturing methods and selection of materials are as essential to maximum general efficiency as good design. Our factory, as a whole, is a model of efficient organization. Our laboratories and means of testing materials to see that they conform absolutely to specifications are as complete as money and brains can make them. Our materials are, in our opinion, the best for their purposes that money can buy. Our machine shop is one of the most complete and best organized of its kind. It contains hundreds of machines specially built to our design. At every turn are found instruments of the highest precision used to assist in maintaining standards and detecting flaws. These instruments are the fingers of an inspection system of far-reaching efficiency. Our experts are familiar with the best automobile shops of both the United States and Europe and our claim of excellence is based on direct comparisons. Our limited output enables the specialists, who are our department heads, to give their personal attention to every assembled unit that leaves each department. Every owner gets the full benefit of the long experience of each of these specialized brains. He gets a custom-made article.

Pierce-Arrow service is designed to assist the owner to obtain maximum satisfaction from his car. We know that our cars should be splendidly efficient and we mean to see that they shall be.

We assist our agents in giving this service through the mediums of our traveling roadmen, our semi-annual school for their shop foremen, and by providing them with expert advice in regard to shop organization and equipment. This Pierce-Arrow service extends all over the world. From San Francisco to Budapest, from Los Angeles and San Antonio to Halifax, a man may take his car where he pleases and yet remain within reach of expert help.



48 H. P. B-2 Suburban



1902

PIERCE-ARROW TRADITION

MUCH has been said of the tremendous responsibility of the locomotive driver, but little, if anything, of the responsibility of the men who design and build that locomotive. A defect in design or workmanship may mean death to a score of passengers. Locomotives run on a carefully prepared roadway and are constantly and minutely inspected.

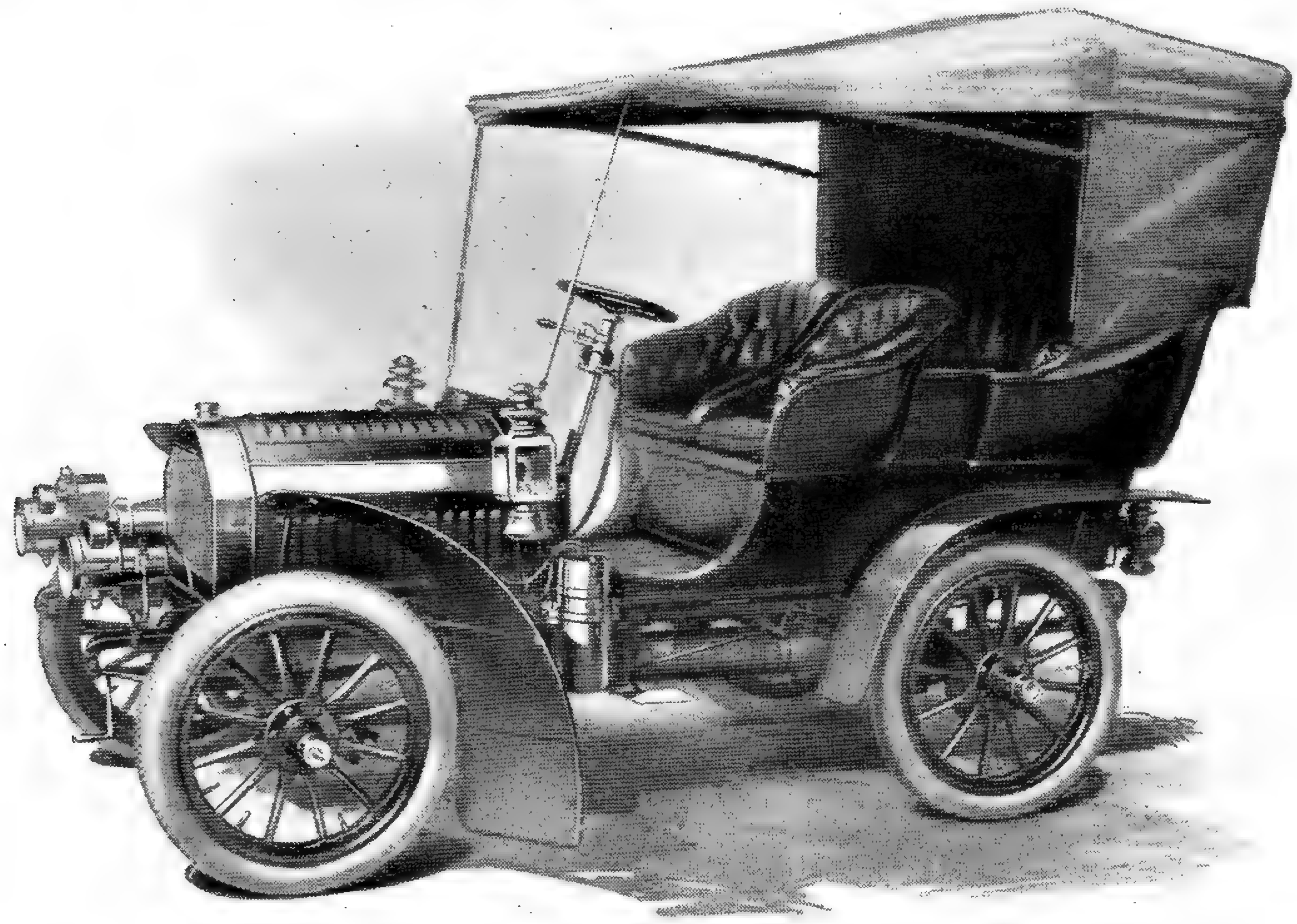
A good deal has been said in regard to the care and coolness that should be brought to the driving of an automobile. Any one thinks he can, and almost every one does, drive an automobile. He drives through traffic, up and down mountains, over rough and smooth roads, and at all speeds. He has no fear, nor, unless he is very foolish, need he have. The makers of the car take most of the responsibility.

Because our engineers realize and respect this responsibility, the Pierce-Arrow car is, before everything, safe.

Take just one example. The habit of a lifetime is not easily broken. With ninety-nine out of one hundred automobile drivers, the right-handed habit is of life-long duration. For this reason, we do not favor a drive with a left-hand control. In an emergency, when seconds count, the driver might fail to properly and instantly operate the emergency brake. We refuse to take that responsibility.

Any normal man — or woman — can drive a Pierce-Arrow car anywhere a car should go in perfect safety.

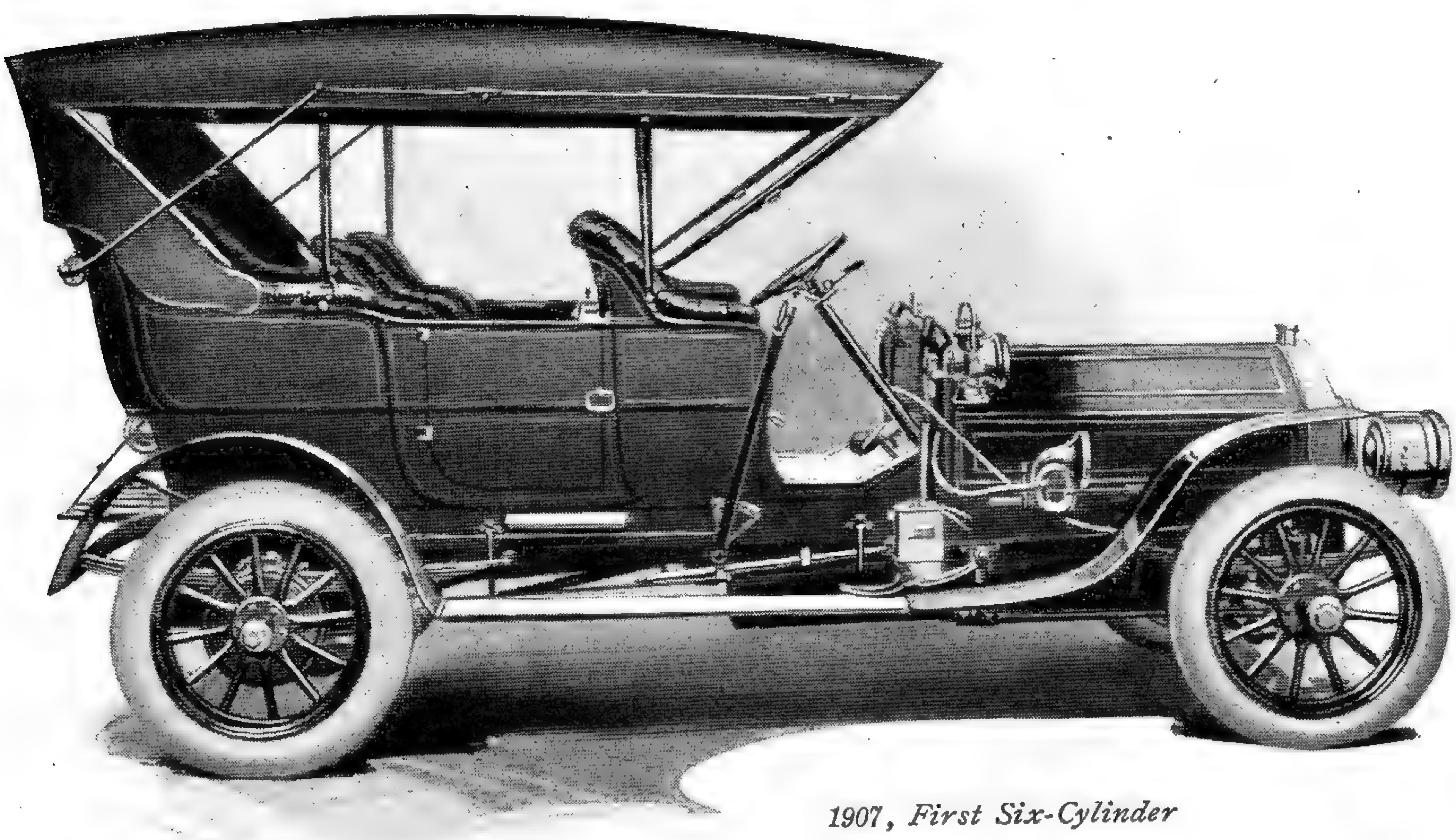
In order to conform to our ideas of maximum efficiency, a motor car must be



1903

not only safe but absolutely dependable. Dependability means trustworthiness. It means absence of anxiety on the part of the owner of a car, no matter where he wishes to go.

During the summer of 1912, a gentlemen and his wife toured Europe from the north of France, through the tremendous climbs and descents of the mountains of Switzerland and the Austrian Tyrol, across the sun-baked plains of northern Italy, and back through the Black Forest and Germany. The distance run was over 3,000 miles.



1907, *First Six-Cylinder*

"A good trip, but nothing unusual," you will say. We agree with you, but, perhaps, you will change your opinion when you know that the gentleman and his wife are nearing seventy years of age; that no chauffeur or servant accompanied them; that Mr. ——— knew where and when to oil and grease the car (he followed our printed instructions), how to steer and operate the controls, but not one other single thing. He had no trouble, and was enthusiastic about his trip. The car was a 36 H. P. Pierce-Arrow.

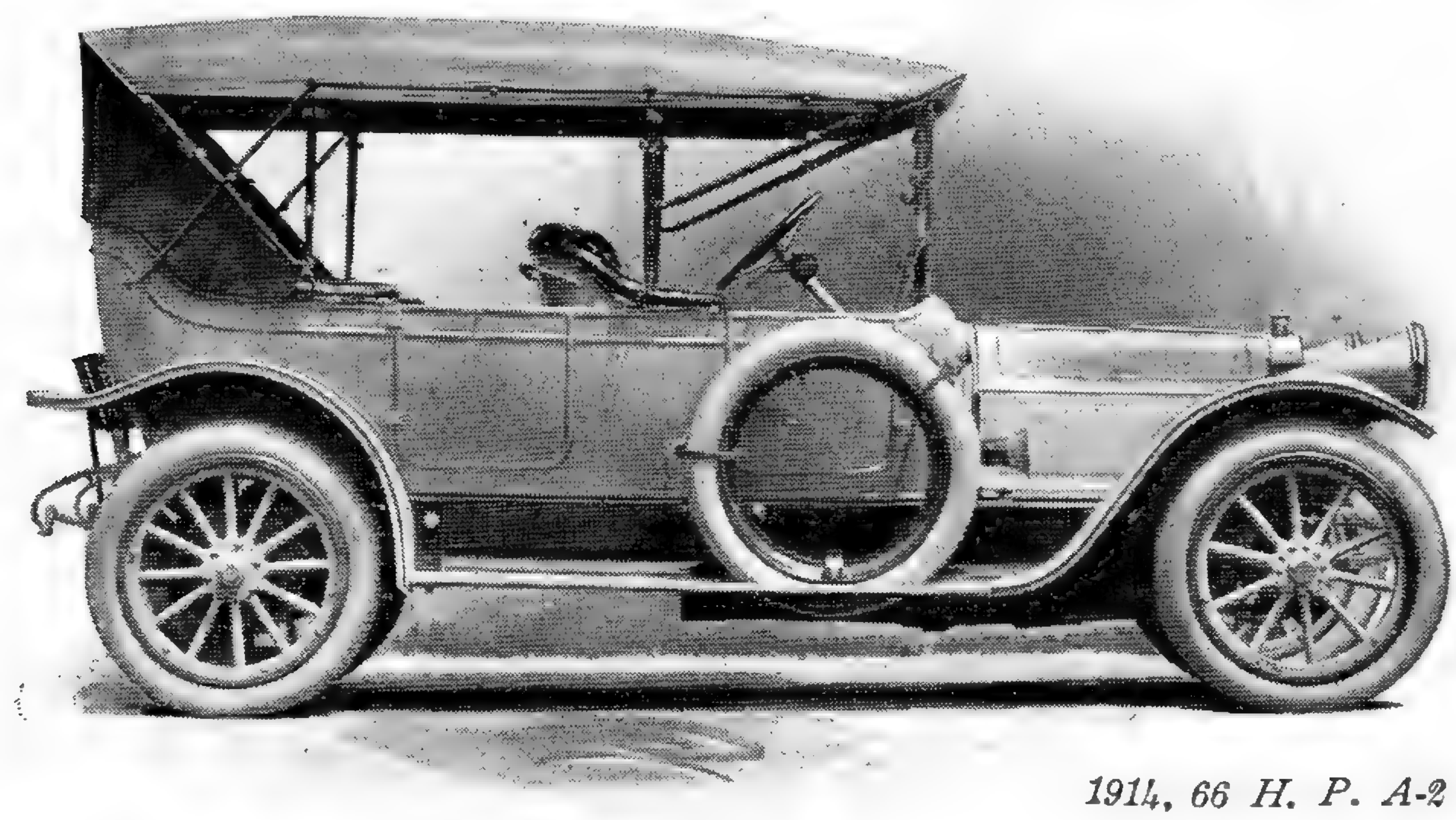
Between January 1st and May 1st, 1902, the first twenty-five Pierce-Arrow cars were built. This first model was a $2\frac{3}{4}$ H. P. Motorette, seating two passengers and equipped with a single-cylinder imported motor. Since that first modest start we have turned out almost 12,000 cars, of thirty-eight different models, ranging from the single-cylinder $2\frac{3}{4}$ H. P., through the 2-cylinder 15 H. P. and the 4-cylinder 45 H. P., to the present 6-cylinder 66 H. P.

Not one of these thirty-eight models but has been a complete success. The men who designed and built the little Motorette have also designed and built the big 66-A-2. The policy of the company to build the best, regardless of cost, and sell it at a fair profit has never been changed.

The above record has had one peculiar effect.

Many people buy Pierce-Arrow cars without looking at the motor, without considering one single mechanical feature. Such people know that "Pierce-Arrow" means "maximum efficiency." They don't have to think. Our engineers do the thinking. Our owners can buy their cars on trust because our engineers build nothing on trust.

Before we place our name-plate on a car — sign it — we know we shall never wish to retract that signature. We know that car is worthy of its ancestors. It may be new to the public, but it is an old, old story to us. We do the testing of our new designs; the public uses the cars. We know that each model we turn out will add one more link to the splendid chain of Pierce-Arrow tradition.



1914, 66 H. P. A-2

DESIGN

A WELL-BALANCED general performance calls for a well-balanced design. The public is apt, at times, to make a comparison between the maximum performance of a well-balanced car, in one particular direction, and the maximum performance of a specialized car, in the direction of its specialty. Such a comparison is manifestly unfair and can be made only by people who fail to appreciate the meaning and advantages of balance in a pleasure touring car.

There is an interesting parallel to be found in comparing the purchase and use of horses with that of automobiles. A man buys several teams of heavy dray horses — or a truck — to do heavy hauling. If, however, he wishes to make a show on the speedway, or to travel faster than other people, he buys a nervous, delicate trotter — or a racing automobile. Between these two extremes lies the case of the man who wants a conveyance strong enough to take him and his family anywhere that roads lead, take him in all safety and comfort, and get him there in good time. This man will buy medium-weight horses, strong enough to pull the load required, yet not so powerful as to be slow and clumsy. He will buy horses fast enough to go a good day's journey before dark and yet not so fast as to be lacking in safety, in stamina, or in comfort. Or, he will buy a maximum efficiency touring car.

The significance of this parallel is not confined to the power plants of the different conveyances. Not only must the horse be suitable for the service required, but the carriage he draws must also be adapted to this service. Not only must the motor, transmission, and running gear — the power plant — of the automobile be considered, but the body as well. Neither the heavy dray, used for hauling purposes, nor the sulky, used behind the trotter, is a particularly comfortable or restful conveyance in which to go a day's journey. Yet each one is eminently suited to the purpose for which it is used. Similarly, in a car designed to be very speedy, comfort must be sacrificed to lightness. The maximum efficiency touring car is as fast as is consistent with comfort, as comfortable as is consistent with durability, and as safe as it can be made.

It requires an extreme design to produce extreme results and it also requires an extremely nice balance of design to produce the All-Roundness of the Pierce-Arrow touring car.

This nicety of balance and all-round efficiency is beautifully illustrated in the design of the Pierce-Arrow 6-cylinder motors.

Take, for instance, the proportioning of the motor in connection with the required power to be developed. Very much that is ridiculous has been said regarding bore and stroke ratios. The ordinary automobile owner, or prospective purchaser, is liable to be holding a strong opinion in this connection based not at all upon facts. The most common of these opinions, is that upon

the length of the stroke of a motor compared with its bore depends its power — regardless of any other consideration.

Without going too deeply into technicalities, it may be stated that motors having the same compression and mechanical efficiency, together with the same piston displacement, will develop the same, or nearly the same, horse power at corresponding rates of piston speed, quite regardless of the ratios of strokes to bores.

Other things being equal, bore-stroke ratios have little to do with power efficiency. They have, however, much to do with silence, flexibility, weight, and durability. The medium ratios give the best general results — the best balance.

Pierce-Arrow motors are medium long-stroke motors.

With the same care and in the same manner as they have studied the motor proportions to attain the best all-round efficiency, our engineers have approached the designing of every part of the car.

The cone clutch is recognized by the majority of designers the world over to be the simplest, the most dependable, the lightest, and the most easily understood and most readily adjusted type of clutch. It is also by far the cheapest to repair if worn or abused. Being entirely open to the air, it radiates heat readily and is less likely to be damaged from continual slipping in traffic or many starts.

At the London Automobile Show of 1912, 58 per cent. of all cars exhibited were fitted with cone clutches.

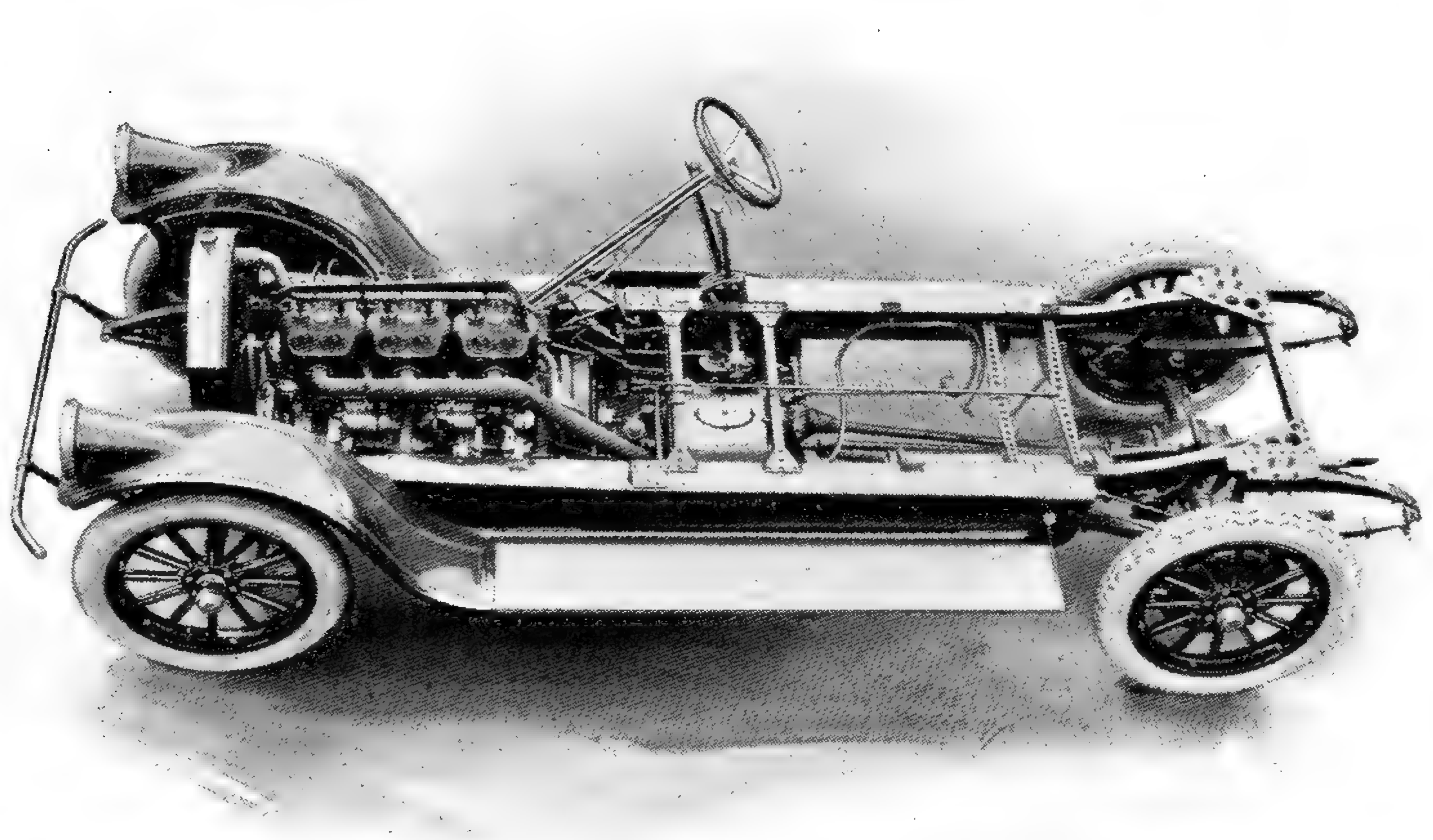
All the motor omnibuses owned and operated by the London General Omnibus Company, Ltd., are built by them particularly for their work of threading the congested traffic of the largest city of the world, and all of them are fitted with cone clutches.

Our four-speed, selective transmission is located in the position and suspended in the manner that is rapidly becoming standard for all high-powered automobiles. Believing that it is far better to have gears that will wear for an indefinite period than to attempt to attain absolute silence at the expense of durability, we use gears that, though having a tendency to ring, will practically never wear out.

Our rear axle design has proven, through a decade of service, its absolute reliability and durability and is, as well, simple, light, and silent.

Too much stress cannot be laid on the desirability of a light-weight rear axle. In addition to the excessive wear on tires due to the additional unsprung weight of a transmission carried integral with the rear axle, it should be borne in mind, that the greater the proportion of the total weight of the car carried above the springs, the greater will be the comfort of the passengers.

It is, of course, perfectly possible to proportion the springs of any car, no matter how light, so that a fixed live load can be comfortably carried. If,



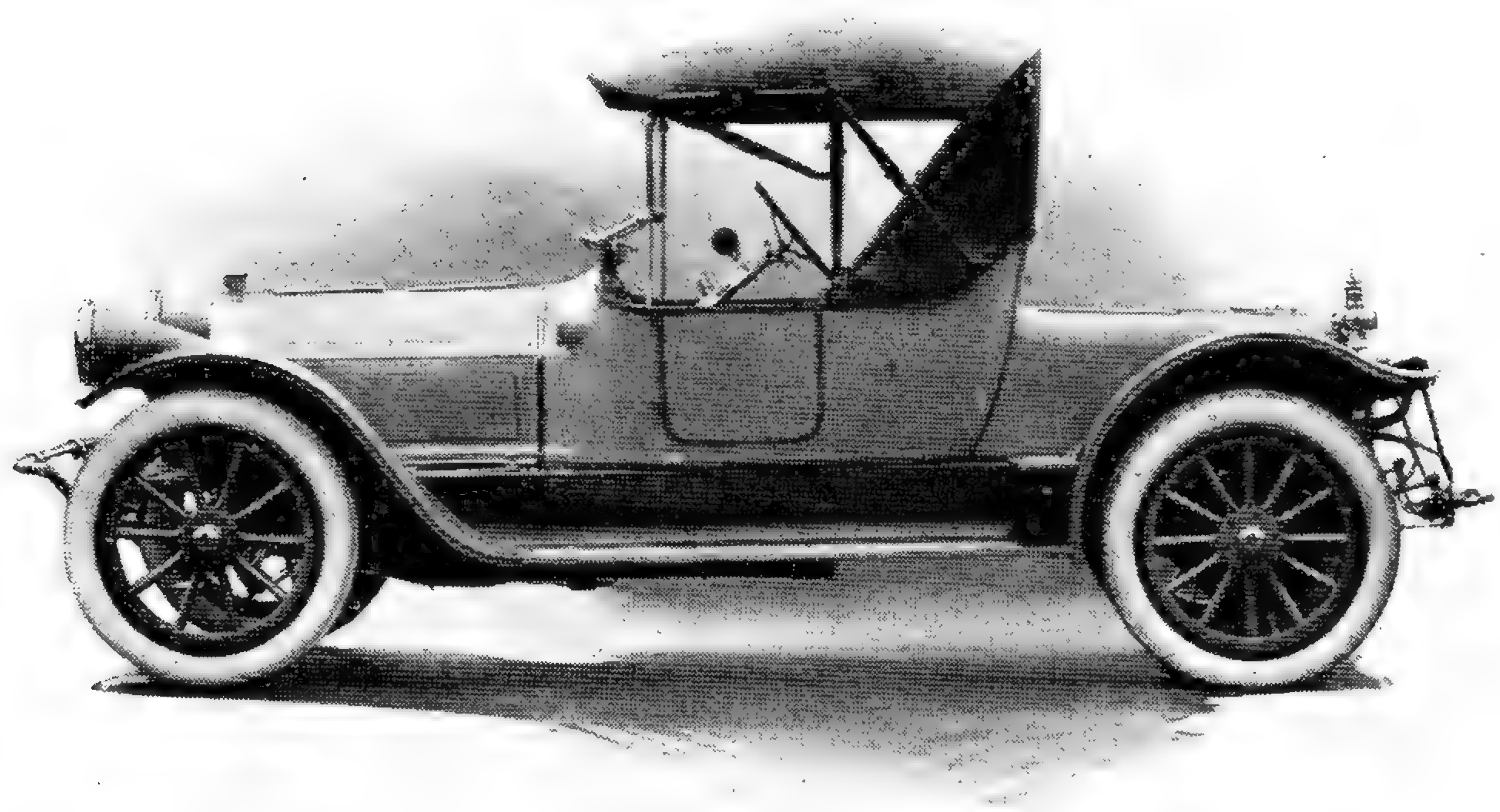
however, the car is designed to carry a number of passengers, this live load is not a fixed quantity. If a car which is very light above the springs is comfortable carrying seven passengers, it stands to reason that if but one or two passengers are carried, the suspension will be too stiff. If the suspension be made flexible enough to enable one or two passengers to ride in comfort, it will be entirely too flexible when a full load is carried. The heavier the dead load, within reasonable limits, above the springs, the less will be the proportionate variation caused by the difference in the number of passengers carried. For this reason, it is extremely desirable that the weight of the gear box be carried above the springs instead of below them.

In the early history of the manufacture of Pierce-Arrow cars, we tried radius rods, for the same reasons that certain manufacturers are using them to-day. The same may be said of a number of the best foreign designers. These last named, as well as the Pierce-Arrow engineers, soon found that these reasons had no substantial basis of fact in connection with a touring car. It was discovered to be much better and simpler in design, besides giving a certain amount of elasticity to the drive, to use the top leaf of the lower member of the rear springs to transmit the driving and braking thrust. We had considered that it would be necessary to greatly increase the weight and strength of the springs to perform this work, but we quickly found that this was not the case.

The worm-and-nut type of steering gear, that we have employed for so many years, has such very decided advantages over the ordinary irreversible worm and wheel type that we are at a loss to understand why these last are used at all; unless it be due to the fact that the worm and nut cost about twice as much to properly manufacture and fit. The total bearing area of the worm on the wheel

is, theoretically, but a line, and in reality considerably less than a square quarter of an inch, while the bearing area of our worm-and-nut gearing is over six square inches. Our steering gears need no adjustment even after sometimes three or four seasons of constant work. In addition to the above difference, it should be remembered that the worm wheel is bound to wear more through its central portion than at the ends, and that this wear can be in no way taken up. If the attempt to adjust the worn central portion is made, it will be quickly found that the unworn ends of both worm and wheel will bind if the worn middle is caused to work without undue play.

Those who are disposed to criticise Pierce-Arrow design should remember the record of long years of unbroken success that our cars have enjoyed. It would be most instructive to such critics to inspect the records of our experimental department. They would see that there is hardly a single type of motor, transmission, or any other part of a car, that has not been entirely and completely tested out. They would appreciate what we mean when we say that our engineers have done the thinking and all that the owners need to do is to use the cars.



THE FACTORY BEHIND THE CAR

THE general superintendent of one of our high-priced competitors, who prides himself upon the efficiency of his machine shop, was being shown through our plant. He stopped before a machine and delivered himself as follows: "My, but you're behind the times. We make that part on a machine that costs over twice as much as this one and it costs us only $1.20. Of course, your piece is a bit better than ours but you certainly should put in that machine."

This man admitted that the part we were making was of higher grade than his. He admitted that it should, for that reason, cost a little more to make than his part, even if we used the expensive "labor saving" machine he employs. He was rather more than surprised to learn that the making of our better piece on our cheaper machine cost us just $0.86, a saving of over 28 per cent.

This making of a better piece, on a cheaper machine, and at a lower cost, is typical of Pierce-Arrow efficiency.

There are many makers manufacturing medium-efficiency cars in very large quantities whose shop costs, for quite inferior parts, are higher than our own. Not one of them has lower costs for equal grades of workmanship and design.

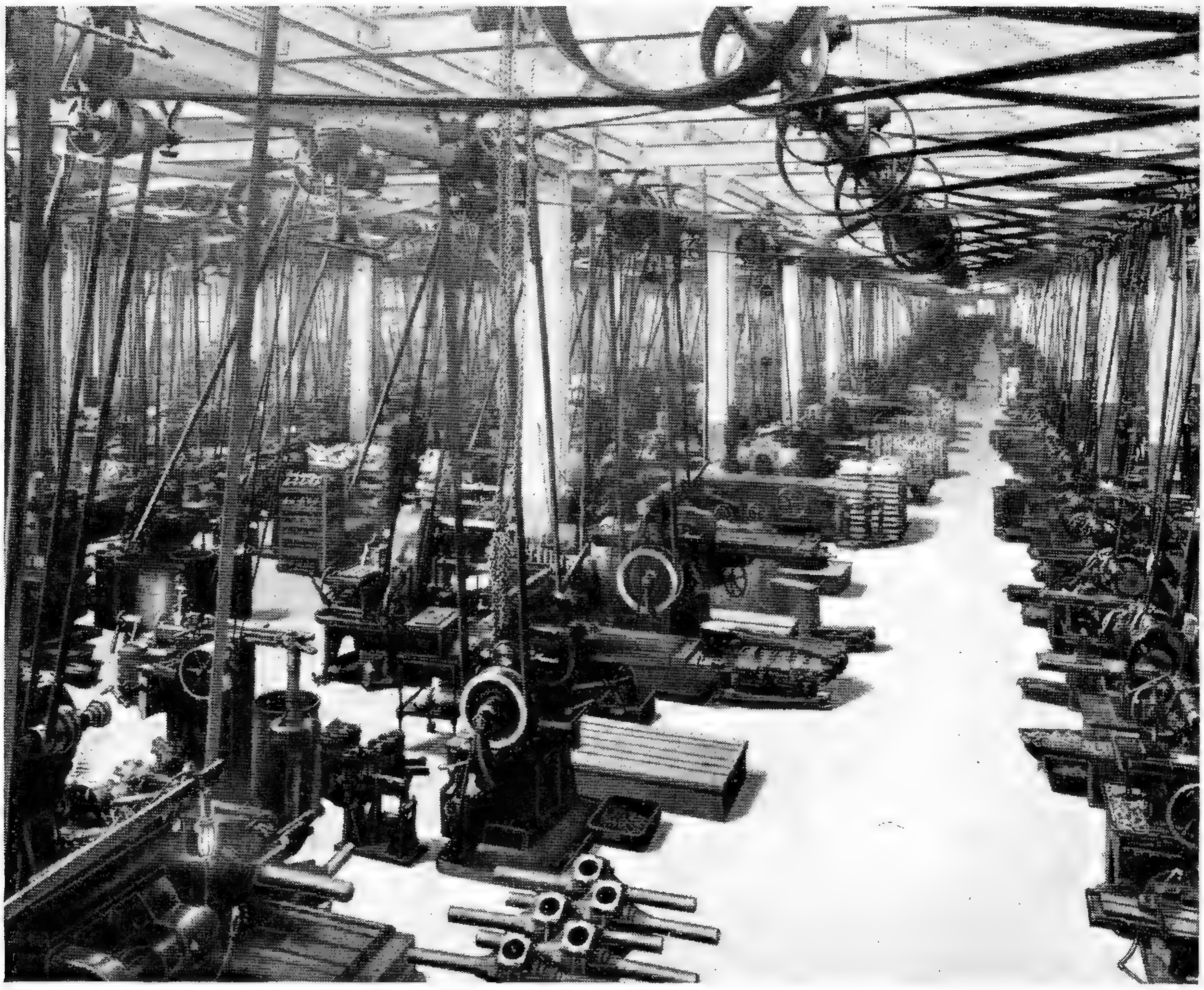
The benefit to the purchaser of a Pierce-Arrow car from this extreme efficiency is that, by reducing manufacturing costs to the minimum compatible with the highest standards of workmanship, we are enabled to sell our cars at a lower price than would otherwise be possible. It is safe to say that no other existing organization could build a car as good as the Pierce-Arrow and sell it for the same price — without losing money.

That is why a Pierce-Arrow is the best bargain in the automobile market.

We have found by experience that a minute inspection of each piece after each operation is cheaper, by a large percentage, than a single inspection when the piece is finished. The scrap is greatly reduced and no work is wasted on a piece already defective. We have tried inspection at the machine, but this method proved uneconomical, and now, after every operation, each piece is taken to the inspection room before more work is done on it.

Our policy is to inspect before working. Many a casting never even enters our stock room, as all are carefully inspected in the receiving room before acceptance. Very few fail to pass final inspection, for final inspection is little more than a verification of the last operation.

The Inspection Room runs the whole length of one side of the machine shop; over 400 feet. In it are located the 135 trained men working under their six sub-foremen, one general foreman, and the Superintendent of Inspection, who form the inspection force of the machine shop. These men are equipped with the finest precision instruments that can be found, and, wherever possible, the



Machine Shop

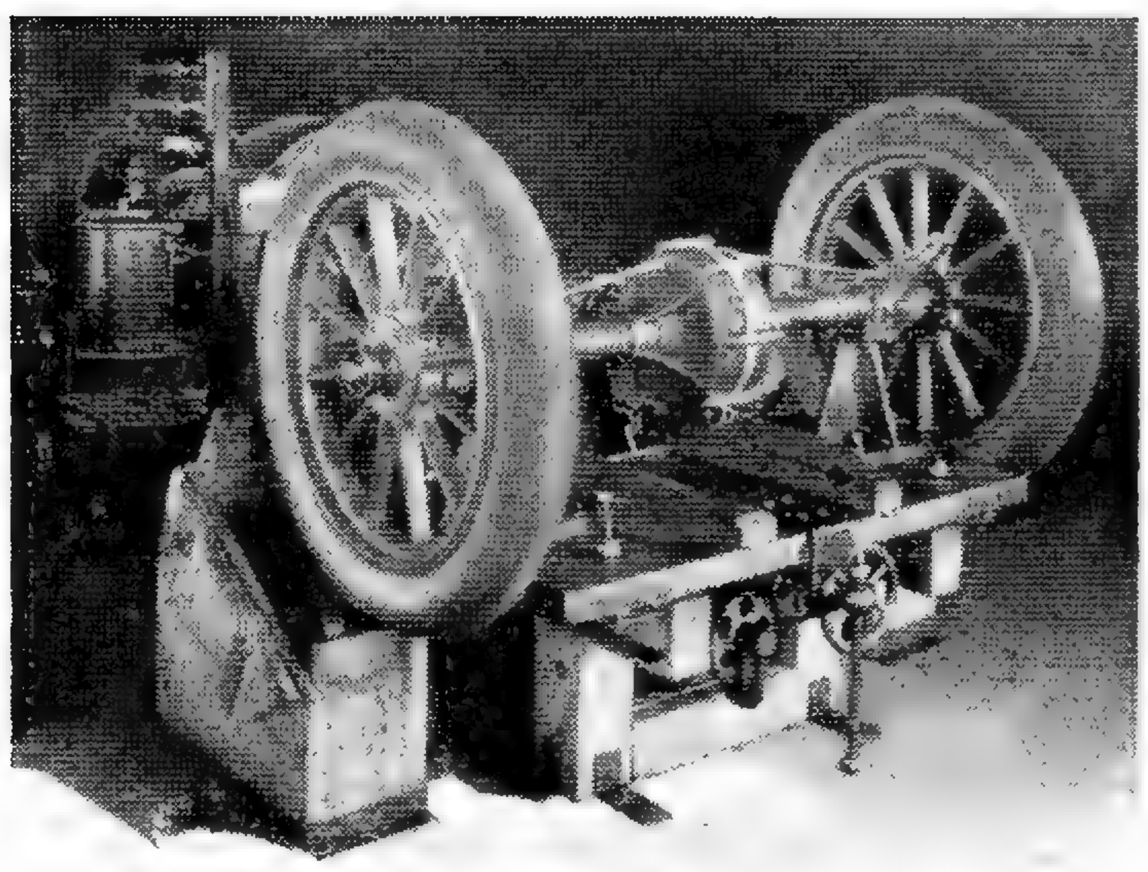
instrument is of the automatic kind adjusted to a standard piece. These instruments eliminate absolutely the factor of personal error.

Beside each machine tool is a rack onto which the pieces are piled by the operator after the work on them is finished. These racks are so designed that a special patented truck can be slid under them. This truck, by means of pressure on a pedal, is made to lift the rack and load of pieces, often a ton and a half in weight, and transport them without handling to the inspection room. Much of the internal transportation in the Pierce-Arrow factory is done by electric power trucks, hand trucks being used only where absolutely necessary.

We do not, for most purposes, believe in the all-around mechanic. Our men are specialists. Many of them have been working on the same kind of machine, making the same kind of piece, for over ten years. Some were with the company in the old bicycle days and have been doing the same kind of work for almost twenty years. These men become part of their machines and our low-production costs are inseparably united with their efficiency. They make more money in this way — our machine-shop work is mostly piece-work — are more contented in consequence, and the service they render is of a kind not to be easily duplicated.

Pierce-Arrow machinists are Pierce-Arrow machinists for life, and they, together with the owners of Pierce-Arrow cars, derive the benefits from their maximum-efficiency specialized work.

Any one can buy the same kind of machines that we use, unless they happen to be designed and patented by us. Any one can have the shop equipment and arrangement — but they cannot get the men. It is the man behind the machine that makes the factory behind the car what it is, and enables the purchaser of a Pierce-Arrow automobile to secure the best bargain on the automobile market.



Rear Axle Testing

DURABILITY

It has been previously stated that durability means slow depreciation and that slow depreciation is synonymous with low cost. That statement is not in any way an exaggeration. No more is it an exaggerated statement to say that a car built to a maximum-efficiency standard, regardless of selling price — built in the Pierce-Arrow way — is far more durable than a medium-efficiency car built to market at a fixed medium selling price.

A new Pierce-Arrow car, at list price, is the best bargain — real bargain — on the market. People do not sell articles very often for less than they are worth — to them. They keep their Pierce-Arrow cars. Pierce-Arrow cars do not wear out.

Go into the market and see how much you will have to pay for a second-hand Pierce-Arrow of any recent model. It will be as much, perhaps more, than you would have to pay for the latest model medium-efficiency car, the car built to a price.

Is this not a significant fact?

These other cars are "up to the minute" in size, power, accessories, and, occasionally, comfort and beauty. Yet a Pierce-Arrow car, used and approved through several seasons, run many tens of thousands of miles, is worth as much, or more, to its owner, than the other new, "up to the minute," medium-service car.

In that commercial fact is to be found the value of durability and the proof of the statement that a durable car is the cheapest to own, though it can never be the cheapest car to buy.

On the 20th of December, 1912, The William H. Brown Co., writing us from Montana, said in part:

> "We have in use at this office two of your 45 H. P. seven-passenger cars and one of your 1906 models, which are giving exceptional service. Our 1906, 45 H. P. car has been driven over 170,000 miles and is in active service every day, and we do not know of any other car on the market which will do the same amount of work, over all conditions of roads, as the Pierce-Arrow and with the same up-keep."

The cars mentioned in that letter are being used by a big real estate company to show prospective customers wheat lands. Not suburban house lots, but ranch country, where a customer may be driven all day, for several days, over rough roads or no roads at all. That company buys automobiles as a business investment, and it buys Pierce-Arrow automobiles because they are cheaper in the long run — because they are durable.

This car was built in 1904 as an experimental model. It was the first direct drive on high speed. It is a duplicate of the car that won the first Glidden Tour, driven by Percy Pierce and George Ulrich, and carrying as passengers Mr. and Mrs. Pierce.

The "Skidoo Wagon" has run approximately 300,000 miles in the service of the Company and is practically unchanged in mechanical composition.

COMFORT, CONVENIENCE, AND BEAUTY

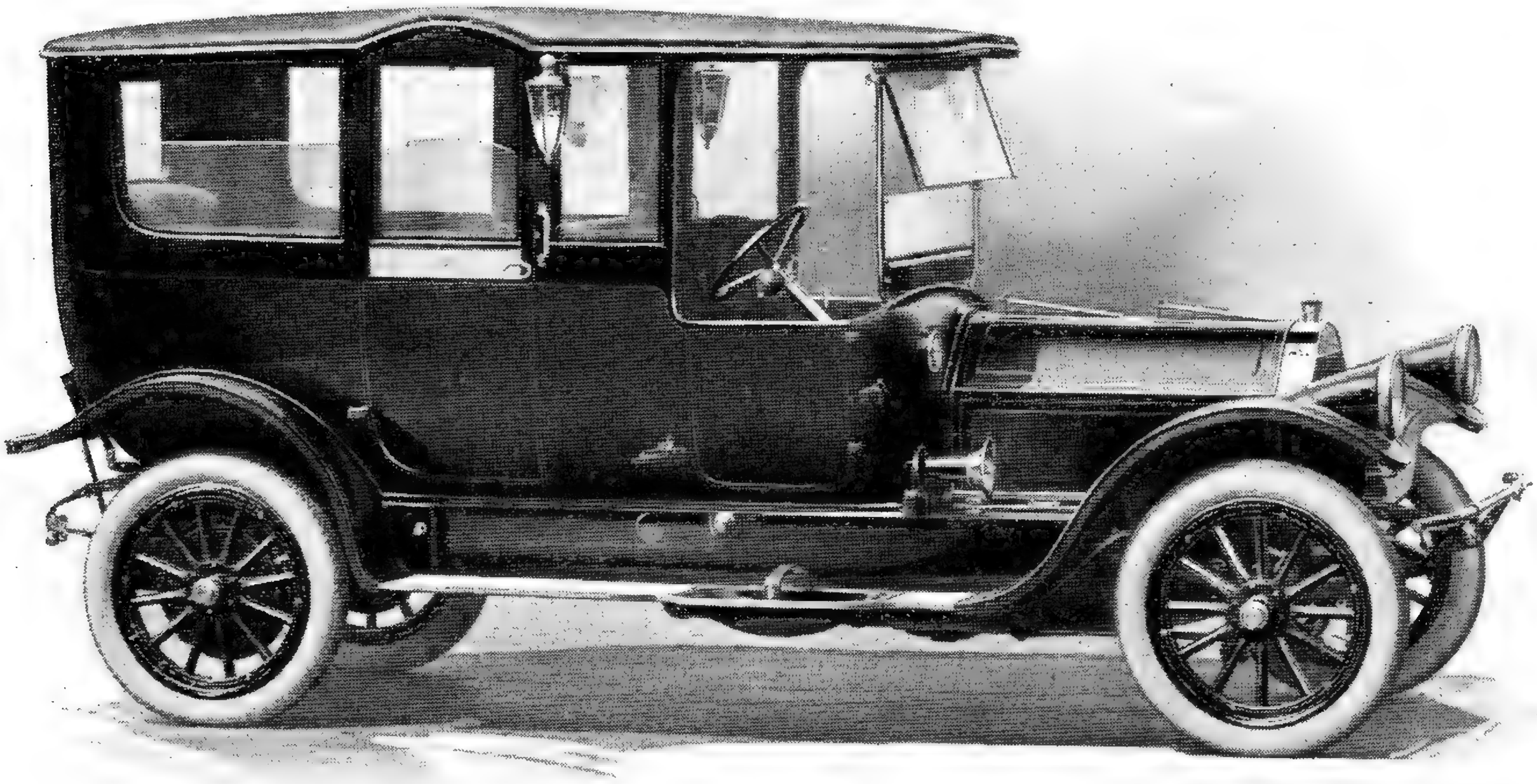
EVERY successful example of architectural achievement is one wherein good and logical construction is so inseparably united with good decoration that the two are merged into one harmonious whole, of which it might be said that the structural features are beautiful and the ornamentation structural.

It has been the constant aim of Pierce-Arrow body designers to create this harmony in all Pierce-Arrow models.

The style periods named after the French kings of the seventeenth and eighteenth centuries produced furniture that is very beautiful to the eye. Lines, proportions, material, color, and decoration are all most harmonious, but from the point of view of comfort, the chairs and sofas of these periods are most inadequate.

A motor-car body that is uncomfortable is a failure, no matter how beautiful and satisfying it may be to the eye.

The most painstaking care has been exercised by the designers to secure the maximum of comfort and convenience in all Pierce-Arrow cars. Distribution of weight, type, and proportioning of springs and reaction dampeners — commonly called "shock absorbers" — tire equipment, and the proportioning of seats and upholstery, are all elements that must be carefully considered.



66 H. P. A-2 Suburban

There is, probably, no single phase of automobile design that calls forth so many diverse expressions of opinion as to the proportioning of seats and their cushions.

That this should be the case is, for the automobile manufacturer, perhaps unfortunate, but the condition is bound to continue until such time as the growth of the science of eugenics has made it possible to standardize the dimensions and design of the human frame. Fashion, in women's clothes, has, too, a most important bearing, and the attainment of uniform practice in this direction seems even more remote than in that which determines the length of limb and general proportions of the occupants of automobile seats.

As an illustration of the impossibility of constructing a seat that will absolutely suit even the majority of automobile users, it may be interesting to cite an experiment carried out some time past at the factory.

A skeleton seat was constructed, with adjustable plugs so arranged that it was possible to get the exact angle and contour of the sitter's back. Out of thirty subjects measured, no two showed the same conformation. From these measurements, however, it was possible to draw an average contour that would closely approximate the absolute "comfort curve" of the majority of automobile users.

All standard Pierce-Arrow bodies are fitted with seats built along the lines indicated by the above experiment and are provided with a type of cushion best suited to give the least fatigue to the average occupant of the car.

As the automobile is seldom used by but one person, it has always seemed to us desirable that its seats should be proportioned and upholstered so as to give the greatest average comfort to all those who will use them.

To the attainment of this greatest average of comfort we bring many years of experience and study. There is hardly a degree of softness or hardness or a variation in proportions that has not been experimented with in our body shops. The conclusion that we have reached is one that is quite similar to all other conclusions relating to Pierce-Arrow design. It is a conclusion of balance; a conclusion that avoids extremes. The seat that is too soft is just as uncomfortable as the seat that is too hard. It is very hot, it does not wear well, and, to the person riding alone, it gives a sensation similar to that which would be experienced in riding on a half-inflated balloon.

It is no test of the real comfort of an automobile seat to try it on the salesroom floor. It must be ridden in during a long day's journey to determine its real fatigue-resisting qualities. Comfort in riding is primarily a question of easily maintained balance. The unconscious and continued effort to maintain one's balance in a very soft, "Turkish," automobile seat is just as fatiguing, perhaps more so, than the ungiving pressure from a seat that is too hard.

Pierce-Arrow seats are designed to fit the average proportions of riders and are so upholstered that, in connection with the suspension of the car, the occupant is enabled to easily maintain his balance on a surface neither of "billowy" instability nor rocklike hardness.

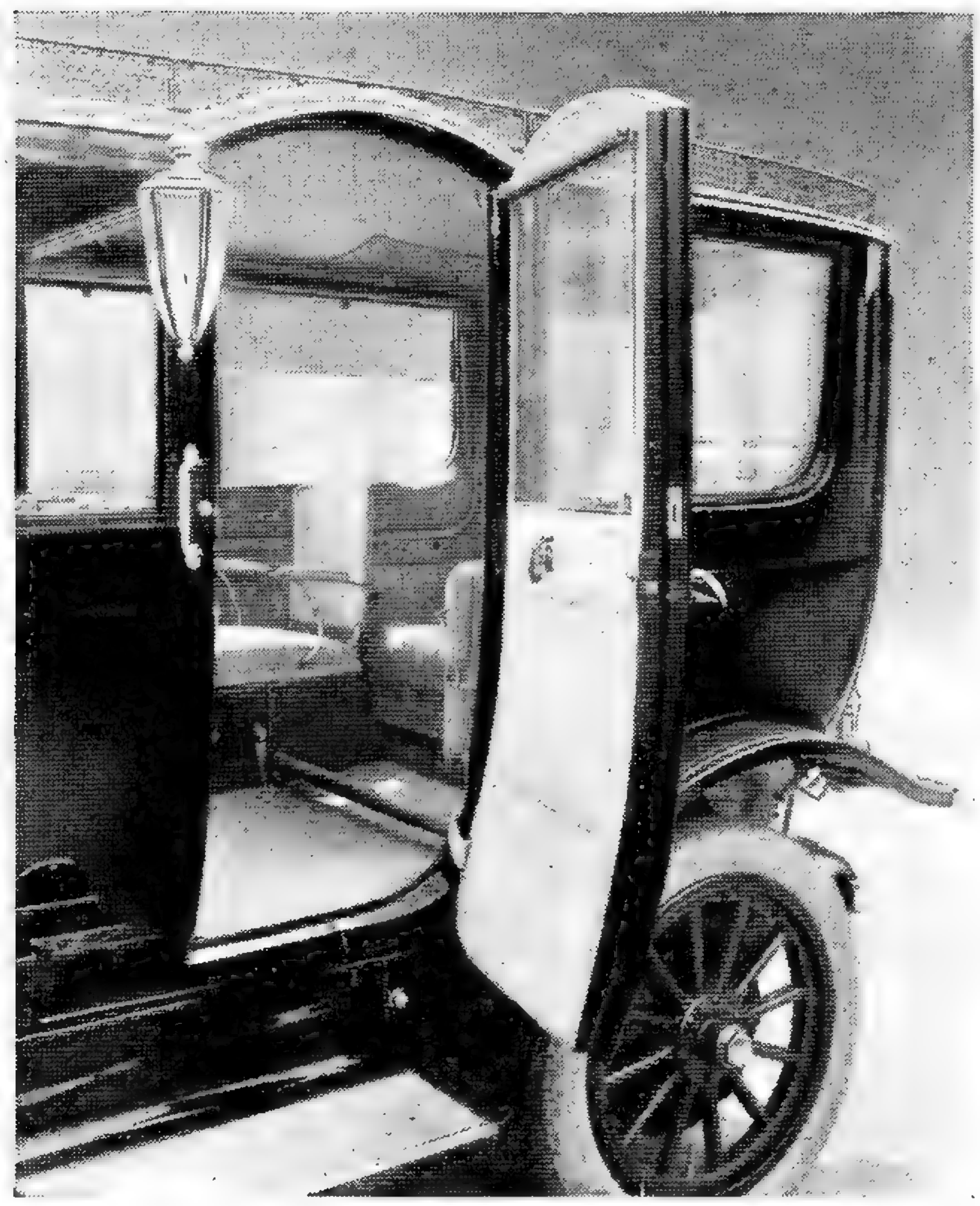
The abnormally small and light, as well as the extremely large and heavy person, requires an especially proportioned seat, and to such purchasers of Pierce-Arrow cars are offered the services of our designing staff to meet their un-average needs. Such service, however, requires time to perform; time and most minute co-operation and instructions from the purchaser. We are glad to equip any car with special seats, but we cannot make such changes unless the complete specifications are in our hands many weeks before the date set for delivery.

The lines of an automobile body, in order to be successful, must not only be structurally correct and suggestive of both comfort and convenience, but must also serve to tie together the component parts of the car into one harmonious unit. They must permit of a variety of attractive color schemes; so that it may be possible to give each car as distinctive and individual an appearance as though it were the only one of its kind.

Every detail of a Pierce-Arrow car is so thoroughly worked out, and fits in its appointed place so well, that one's æsthetic sense must necessarily respond to its appeal.

The designs of accessories, for example, are not left to the judgment of the makers of these articles. They originate with and are carried out by the Art Department at the Pierce-Arrow factory. They are as much a part of the car as any other detail and their success is flatteringly attested by the almost universal imitation, practiced as closely as possible without infringing upon our design patents.

The Pierce-Arrow Art Department is maintained for the express purpose of giving assistance to those who wish to embody ideas expressing their own individuality. This department has had many years of experience in fulfilling the desires of discriminating customers. It is particularly adept in the study of individual color schemes, upholstery combinations and appointments, and we trust that those who are unacquainted with its functions will not hesitate to avail themselves of its services.



San Francisco

SERVICE

WE believe that the purchase of a Pierce-Arrow car should mark the beginning of a long and pleasant relationship between its owner and the great Pierce-Arrow organization.

The value of such a pleasant relationship is very real to both owner and manufacturer.

In order that a motor car shall give the service of which it is capable, it must, first of all, be thoroughly understood, both from the point of view of proper operating and proper care and maintenance. If improperly cared for and operated, the car will fail to give satisfaction to its owner, and, at the same time, fail to maintain the good repute of its manufacturer.

For this reason, the first act incident to the established relationship between owner and maker, or his agent, should be a careful and painstaking instruction as to the best means to be employed to obtain maximum results from the operation of the car.

On the organization staff of every Pierce-Arrow agent there are men who, through years of specialized experience with Pierce-Arrow cars, are eminently fitted to give just the necessary advice and information to owners, and their drivers, to enable them to obtain that satisfaction from their cars which is their

New York

right. We strongly urge that the fullest advantage be taken of the services of these men. Such service means certain satisfaction to the owner and increased repute for the car.

No motor car can be operated without wear and consequent depreciation. The better the design, the material, and workmanship of a car the lower will be the rate of depreciation. If a car be properly maintained and carefully and efficiently overhauled at regular intervals, each overhaul will see it returned to practically a condition of new. We believe that a good car, well maintained, will last forever.

There are four factors which determine the cost of this maintenance:

The first of these is the intrinsic mechanical excellence of design, material, and manufacturing methods. The size of this factor depends entirely upon the manufacturer.

The second and third factors are conditions of operation and care in lubricating, cleaning, and handling.

The size of these two factors is entirely in the hands of the owner, though the Pierce-Arrow Motor Car Company is anxious to contribute all the helpful advice and instruction in regard to operation and care of which it is capable.

A car that is being constantly run at high speeds over rough roads must,

even with the best of care, show more wear than one run over smooth roads at low speeds. The first car will cost more to keep in good running order. The cost of maintaining a car that is not well lubricated, allowed to run covered with mud and grit and driven in a "slap dash," brutal manner must be greatly in excess of that of the well-cared-for, well-handled machine.

The fourth factor in the cost of maintenance is the general efficiency of the shop in which repairs are made.

To reduce this factor to the minimum, commensurate with high-grade workmanship and material, it is necessary that both owner and manufacturer co-operate to the fullest possible extent.

The Pierce-Arrow Motor Car Company, through a long series of years, has given the best endeavors to assist its agents to so organize their shops that our owners may receive the highest class of mechanical attention at the lowest cost, consistent with quality. We believe that no Pierce-Arrow car can be as well repaired in any outside shop as in the shops of our agents. We believe that the special training in Pierce-Arrow methods of construction and fitting that has been given the foremen and mechanics in these shops is a guarantee of the very best workmanship at the lowest figure.

The co-operation that we desire from our owners in this connection is that they make use of the repair and overhaul facilities provided by our agencies to the fullest possible extent.

Chicago

MOTOR

IF there is any one element that contributes more than any other to the position of eminence held amongst its competitors by the Pierce-Arrow car, that element is the Motor.

During eight seasons of experience in designing and building six-cylinder motors, the engineers of the Pierce-Arrow Motor Car Company have learned a great deal. The original six was a 65 H. P. 5 x 5½ inch bore and stroke, built in 1906, and placed on the market as a regular model early in 1907. Since that time, marked improvement in the direction of silence and flexibility has been recorded, while the motor has remained the marvel of balance, dependability and durability, for which it has been noted from the start, and for which it has been extensively imitated.

Many extravagant claims of power are made by manufacturers who, apparently, count on the ignorance of the general public in connection with formulæ relating to horse-power ratings.

The formula adopted by the Society of Automobile Engineers,

$$\text{H. P.} = \frac{d^2\,N}{2.5}$$

is of no value in making comparisons between motors unless its application be understood. The coefficient 2.5 is determined by experiment and calculation to be accurate for average efficiency engines at a piston speed of 1,000 feet per minute. Many people are under the impression that this formula takes no account of stroke lengths, but this is not the case. The piston speed varies directly as the length of stroke, as the following examples will clearly illustrate. A motor having a six-inch stroke will have a piston speed of 1,000 feet per minute at a revolution rate of 1,000 per minute. If such a motor be of average efficiency, the S. A. E. formula will give a close approximation of its brake horse power at 1,000 r. p. m.

A little analysis of ratings applied to our 66 H. P. model may prove instructive. This motor, having a seven-inch stroke, will give a piston speed of 1,000 feet per minute at about 856 r. p. m. The S. A. E. formula rating for this motor is 60 H. P., which, if the motor be of but average efficiency, will represent the brake horse power at 856 r. p. m. As a matter of fact, the motor is of considerably more than average efficiency and the developed brake horse power of the motor at this number of r. p. m. is much in excess of 60. At 1,500 r. p. m. it is over 100 H. P. It should be remembered that any power claim unaccompanied by exact data in connection with Piston Speed is apt to be misleading.

The Pierce-Arrow motor is of T-head, poppet valve-design. It has been, and still is, extensively imitated as a model of 6-cylinder maximum efficiency.

As a manufacturing proposition, it is much cheaper to build unit cam shafts than shafts with pinned-on cams. Our experience, however, has shown us

that the unit shafts cannot give as accurate cam profiles, nor can the motor be timed as accurately, as when each cam is shaped independently of the shaft and set by hand. The cost of replacing worn cams is much less with the assembled unit than when a perfectly sound shaft together with, perhaps, eleven good cams must be discarded in order to replace one worn cam. We have pinned our cams from the start, some 165,000 of them, and we know of less than ten cases where the holding pins have sheared or the cams become in any way loose; a percentage of failure of less than one-half of one one-hundredth of one per cent.

The length of the crank shaft in a six-cylinder motor makes seven bearings for this shaft an absolute necessity. If a less number be used, the shaft must be made of extravagant proportions to resist whipping and springing strains, or else the action of these strains will cause noise, vibration, and rapid deterioration.

Pierce-Arrow engineers use seven bearing crank shafts to insure rigidity, silence, and durability.

The white metal that is used as a surface for all of the crank shaft and big end connecting-rod bushings is made in England, and the proportions of the alloy and the process of manufacture are its maker's secrets. We know, from long experience and many comparative experiments, that it is the best bearing lining on the market.

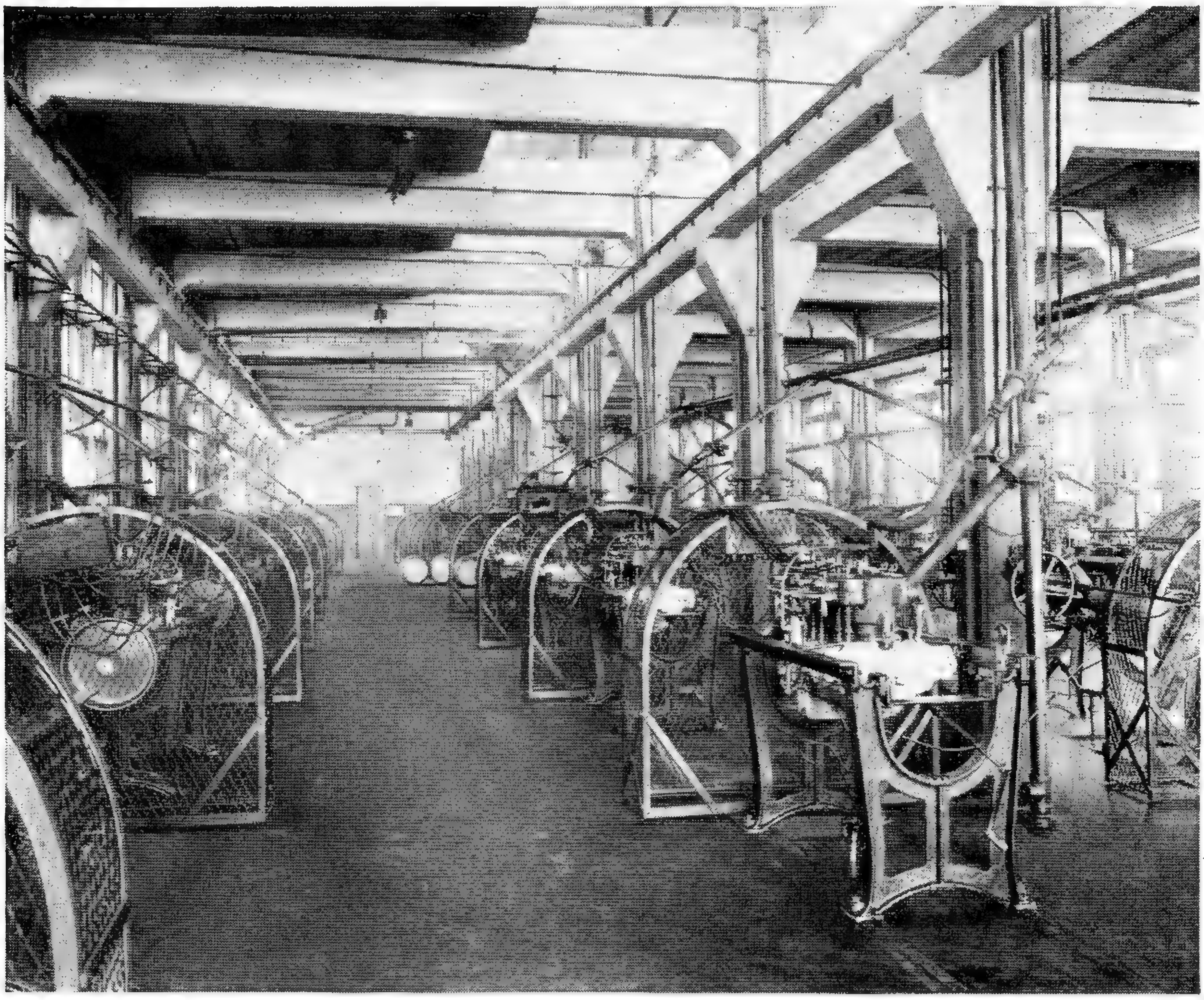
All Pierce-Arrow white-metal lined bearings for crank shaft and connecting rods are made so that they are easily and cheaply adjusted when wear makes adjustment a necessity. The bronze shell that is lined with the white metal may be used indefinitely, it being a simple matter to cast on a new lining.

One great advantage of the thick bronze shell with a thin white metal lining is that, in the case of the burning out of the lining for any reason, the bronze shell will form a sufficiently good bearing with a sufficiently small clearance to enable the car to be run to the nearest repair shop, even though many miles away, without damage to the expensive crank shaft or other part of the motor.

The Pierce-Arrow system of forced feed lubrication using the hollow crank shaft and gudgeon pins together with the ducts on the connecting rods and the centrifugally thrown-off spray, though very expensive to install, is much more simple and positive in operation than any splash system that attempts to provide for starting and stopping wash, varying motor speeds, etc. The feed of the Pierce-Arrow system is absolutely positive and varies uniformly with the speed of the motor. Once properly adjusted, the motor never gets either too much or too little oil, nor is it ever endangered by sediment deposits such as are bound to collect in the undrained small troughs of the better-designed splash systems.

Pierce-Arrow motor lubrication is positive, clean, and accurately proportioned to every change of speed in the motor.

Pierce-Arrow ignition is effected through the medium of two entirely distinct



Motor Testing

and separate systems, neither one of which is in the least dependent upon the other. In addition to the absolute confidence and security in this most delicate function of an internal explosion motor, this absolutely double ignition system affords a ready and easy means of ascertaining if any irregularity of engine operation is due to ignition causes or others. If the motor acts the same when either one or the other ignition is used, it is almost a certainty that the trouble must be sought elsewhere than in the firing of the charge. If there is but one way to ignite the charge, or if the two ways used, as in the so-called dual systems, are intimately dependent upon the same distributer, high tension cables and spark plugs, this facility in locating minor troubles is greatly reduced.

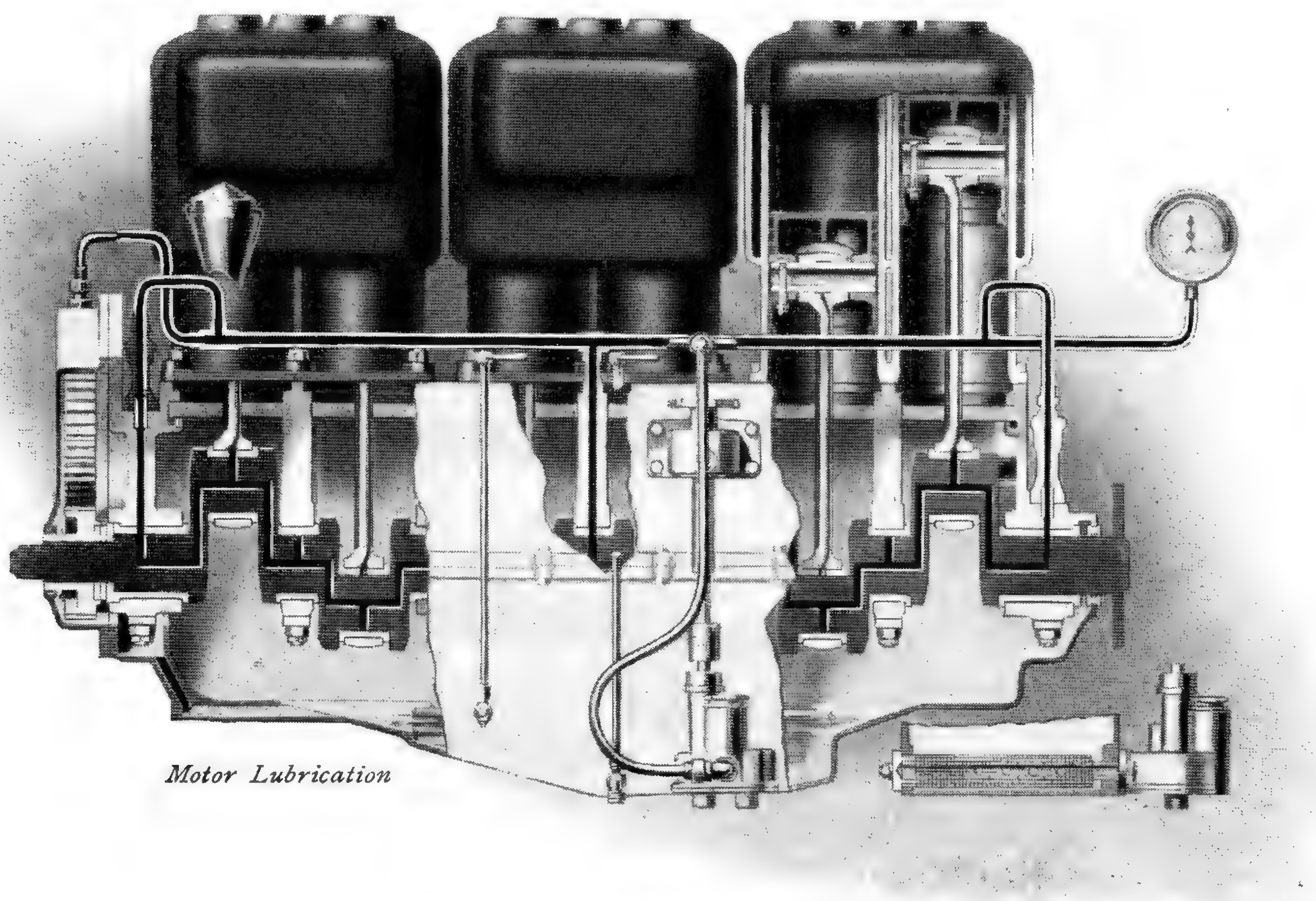
No Pierce-Arrow driver need fear ignition troubles; he has always a complete and independent system in reserve.

The greatest difficulties encountered in designing a carburetor for a motor to be used in an all-around touring car are those in connection with varying climatic, altitude, and fuel conditions, together with the need of extreme flexibility, i. e., power and smoothness at all speeds from the lowest to the highest. Many carburetors give good all-around results in one locality but require intricate and difficult adjustments if the day's run carries them over a mountain or

forces them to use an inferior fuel. Many other carburetors give splendid high-speed results but are almost useless or, at the best, most uneconomical at low speeds. Yet others are the reverse, giving splendid low-speed results but failing on the fast run or long, hard pull.

Ever since the days of those first little imported single cylinder motors, we have been designing and making our own carburetors. Over a decade of experience and experiment has taught us much and we believe there is no more perfect all-around carburetor in the world than the one now on our cars.

Early in the history of the manufacture of motor cars it was recognized that aluminum alloy was by far the best material for the crank case. It is rigid and light and its non-sounding propensities contribute greatly to the silence of the motor. While a splendid material for the crank case, the elastic limit of aluminum is so low as to make it a most undesirable metal from which to make the supporting arms of the motor. In addition to the inherent weakness of a low-elastic limit, it may be pointed out that even the best and most carefully made castings are liable to have concealed flaws that are not to be discovered by the most minute superficial inspection. For these reasons, we adopted as motor supports, drop forged steel girders, heat treated to give the maximum of elasticity. These girders are secured to the crank case by nickel-steel bolts in such a manner as to place no strain on the aluminum case. The front of the motor is suspended by two bolts close together, and the rear by four bolts farther apart. This arrangement of bolts gives what is, practically considered, a three-point suspension, having all the desirable features of that form of design without its lack of stability and ruinous vibration.



Motor Lubrication

ELECTRICAL EQUIPMENT

THE Pierce-Arrow electrically operated engine starter is designed in the Pierce-Arrow way to start Pierce-Arrow engines. It is true that, to make sure of the performance of this service under the most adverse conditions, a factor of safety sufficiently large must be employed to enable the starter, under favorable conditions, to move the car unassisted through a considerable distance. The starter is not, however, designed to perform this service — if Pierce-Arrow engines needed this sort of help they would be redesigned — nor do we recommend that it ever be so employed.

Pierce-Arrow engines, under the most trying conditions of cold and poor fuel, are easily started, with the assistance of the special primer fitted to all models, and our double ignition system, at a comparatively low rate of revolution.

In designing and proportioning the engine starter used on the current models, our engineers have first considered the torque required to turn the different engines, under the most trying conditions, at speeds amply high to insure starting. An electric motor delivers its best power output at a certain speed and the ratio of the gear reduction between electric motor and car engine is determined by this speed and the torque required.

The reductions used in our models will crank the different engines under the worst conditions, without releasing compression, at speeds which we have determined to be certain starting speeds. The design of the whole apparatus is based on these special requirements.

The high starting efficiency of our engines, due to their general proportions and design, the efficiency of the carburetor and the invaluable adjuncts of combined battery and Magneto ignition for starting, and the Pierce-Arrow primer, has enabled us to use a very light, high-speed electric motor, operating at the highest possible efficiency. Under the worst conditions the amount of current used is in no way injurious to the battery, while in warm weather it is barely noticeable.

The Pierce-Arrow engineers have adopted the starting, lighting, and ignition system employing three separate and distinct units. A Bosch magneto, of the latest enclosed type, is used for the main source of ignition current. A secondary ignition is provided in all models operating with the battery as a source of current supply and with separate induction coils and commutators. A special, self-contained, low-speed generator, manufactured for us by the Westinghouse Company, is used in connection with the special starting-lighting storage battery, for lighting and secondary ignition current supply. A highly efficient electric motor, also built for us by the Westinghouse Company, is used in connection with the storage battery for starting the engine.

The advantages of this system are numerous. Each unit is separate and distinct, and may be removed for inspection and repair without, in any way,

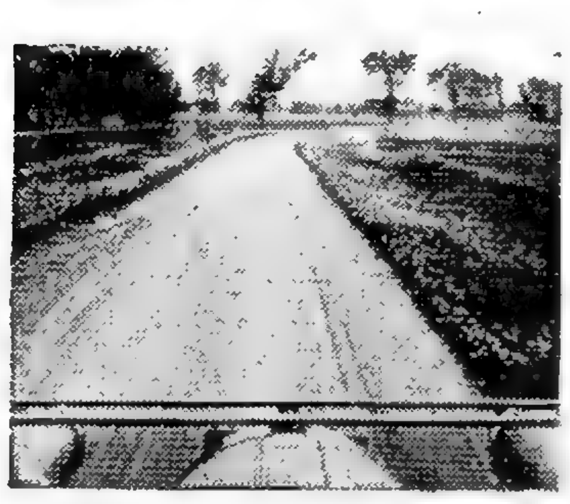
disturbing or interfering with the operation of the other units. If the electric motor becomes deranged it may be removed without interfering in the least with either ignition system or the electric lighting. Should the generator require attention, both the starting, lighting, and ignition continue to function as usual, it only being necessary to recharge the battery, when exhausted, from an outside source. The combined weight of the magneto, generator, and electric motor as installed in Pierce-Arrow cars is as small as that of the lightest of the other systems in use on engines of equal or greater dimensions. Systems using two different voltages are much heavier, due to the need of complicated multiple pole switches.

From the point of view of the tension and volume of current used, there are a number of possible combinations.

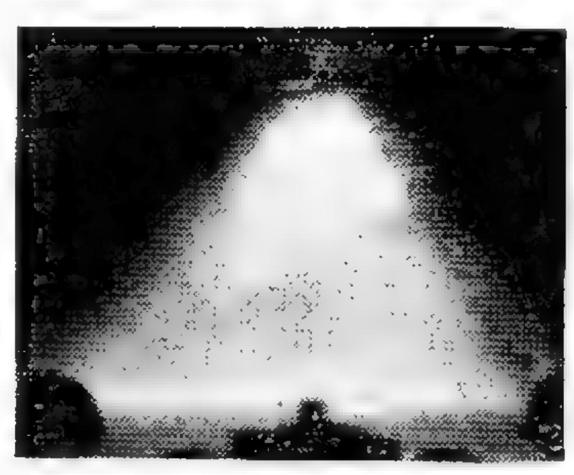
Pierce-Arrow engineers have adopted the system employing a 6-volt current for both starting and lighting. This system enables the lamp bulbs to have large and durable filaments, while the special starting-lighting battery employed is small and light, and its cells, being both charged and discharged in series at all times, are kept in constantly good condition.

The wiring of the Pierce-Arrow lighting and starting system is extremely simple. One-wire circuits are employed, doing away with half of the wiring that so complicates many chassis and obviating more than half the usual derangements due to short circuits. The return conductors are carried in copper tubes attached to the frame. Ground connections are, in all cases, soldered to these copper tubes, and, in connection with the chassis frame, form the feed conductors of the circuits.

This system is designed in such a way as to eliminate any dangerous mistakes in starting or damage that might be caused by throwing the motor into gear when the car engine is running. There is contained in the gear-reduction mechanism a free clutch that allows the shaft to run ahead of the electric motor when the car engine has started to run. All parts, such as gears, shifting rods, starting switch, etc., are incased and protected from dirt and water. This protection of the switch prevents all danger from fire due to arcing. There is an interlocking device that locks the mechanism against accidental engagement when the engine is running, and the removal of the switch plug absolutely prevents the operation of the starter.



DAY AND NIGHT FROM
A PIERCE-ARROW CAR



THE CLUTCH

THE history of the development of the motor-car clutch is similar to that of many other mechanical devices. The first idea, carefully thought out in principle, was abandoned for subsequent and more complicated ideas before having been sufficiently developed in detail. The subsequent ideas, when put into practice, eliminated some of the troubles found in the first designs, but developed other troubles of their own even more serious. Finding this to be the case, designers returned to their first idea and, developing it more in detail, found in it the best solution of the problem.

European motor-car designers began with the cone clutch, but many of them abandoned it before developing its utmost possibilities. Expanding and contracting band clutches, and, later, multiple disc clutches of many varieties were developed, but none of these seems capable of furnishing the ideal coupling between the power unit and transmission.

During the past few years many of them have returned to the original cone idea and, after working it out more in detail, have found it vastly superior to all other types.

American designers have, in a few instances, followed identically this line of experience. Others have not yet reached the last stage. Pierce-Arrow designers have never departed from that first idea, and the Pierce-Arrow cone clutch is the outcome of twelve years experience and specialization.

An ideal clutch must fulfill the following requirements: It must engage smoothly and surely, without shock or jerk and without undue watchfulness on the part of the driver. It must, however, be capable of sudden and positive engagement as, in an emergency, it may be necessary to use the stored up energy in a racing fly wheel to "jump" the car out of a hole — perhaps in a railroad crossing — when otherwise the engine would be stalled. In slow, congested traffic, it must be able to withstand the abuse of more or less constant slipping. It must not make gear shifting difficult, or noisy, through too great weight, by "dragging" or by being "sticky" — a common fault of many types of disc clutches. It must not slip under load and, finally, it must wear well, require little attention, and be easy and inexpensive to overhaul or repair.

The Pierce-Arrow cone clutch combines all these necessary requirements to a high degree.

It was the difficulty of securing smooth and easy engagement that first decided engineers to try the multiple disc clutch. This smooth engagement was secured, but only at the expense of complexity, weight, added cost, and "dragging," and the lack of facility to inspect and repair. Carefully selected and treated leather, an oil ring so designed that a small quantity of neat's foot oil is held constantly in contact with the leather. This lubrication, together with flat springs beneath the leather, give the Pierce-Arrow clutch a smoothness of

engagement unsurpassed by any disc clutch and without any of the drawbacks of the more complex designs.

A comparison between the highly specialized Pierce-Arrow cone clutch, many other cone clutches, and the various types of disc clutches now on the market, proves that the undeveloped cone clutch, while deficient in smoothness of engagement, is yet superior to the disc clutches from all other points of view, and that the development of cone clutch efficiency, as exemplified in the latest type Pierce-Arrow clutch, is inferior to no disc clutch in smoothness of engagement and superior from every other point of view.

TRANSMISSION

THE internal explosion motor delivers its maximum power only through a very narrow range of motor speeds. It is, therefore, necessary to provide a number of different gear reductions for transmitting this power to the driving wheels in order that the motor may be able to do its best work through a wide range of running conditions.

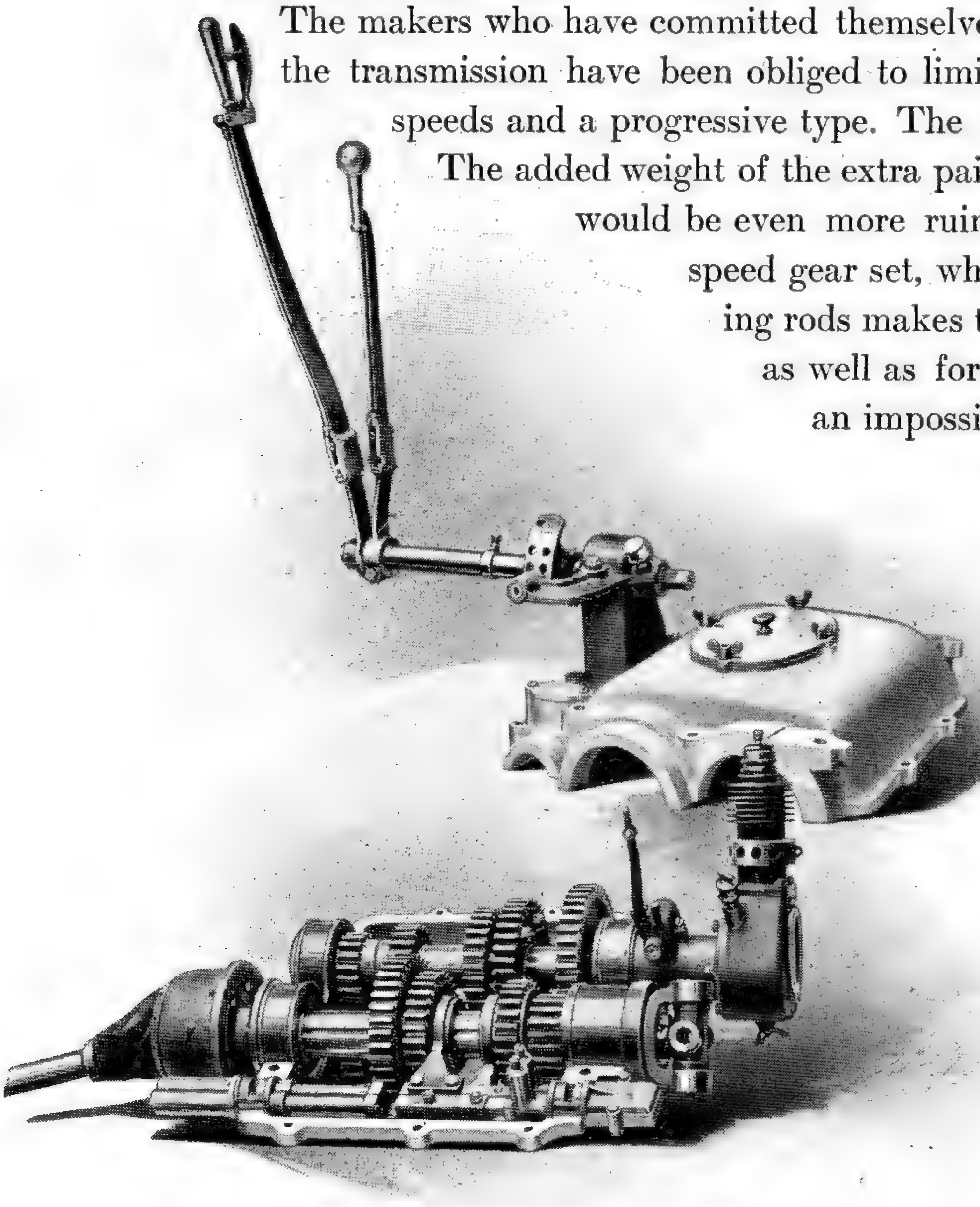
On small light cars, a three-speed transmission, principally on account of its low cost, is "considered adequate." On larger and heavier cars, where the element of cost is not considered as opposed to efficiency, the four-speed, selective transmission is standard.

When mounted integral with the rear axle assembly, the transmission, being unsprung, is subjected directly to all road shocks and vibrations, which have a most injurious effect upon shafts, gears, and bearings. On account of the added unsprung load, the wear on the tires is greatly increased, and this added weight is also a great strain on the rear axle housing.

The makers who have committed themselves to a rear-axle location for the transmission have been obliged to limit themselves as well to three speeds and a progressive type. The reasons for this are obvious. The added weight of the extra pair of gears and longer shafts would be even more ruinous to tires than the three-speed gear set, while the great length of operating rods makes the selective form, with its side as well as fore-and-aft motions, practically an impossibility.

The Pierce-Arrow transmission is a selective, four-speeds forward and reverse transmission; the form that is standard on all maximum efficiency cars.

The selective type is used so that it may be possible to reach neutral position from any gear without passing through another gear, so



Gear Box, Tire Pump, and Levers

that changes may be made from one gear to another without passing through an intermediate gear, and in order to shorten up the gear shafts as much as possible.

While it is perfectly true that the modern six-cylinder motor is usually built with so great an excess of power that, under normal conditions, the intermediate gears need be used only for starting, it should be remembered that much greater range, much longer life, and much greater economy of power — fuel — can be realized if the intermediate gears are used much more than is customary.

If the bevel-gear reduction on a car be made very large the speed range of that car will be greatly reduced, though it will be less frequently necessary to descend from direct drive. If, on the other hand, the bevel reduction be made smaller, under favorable conditions, the car can run at a very high rate of speed, and when conditions become unfavorable, a change into the next lower ratio provided by the transmission can be made. By operating in this manner the speed range of a touring car is greatly increased.

Pierce-Arrow transmission gears are made to use. It is a real economy to use them, and their use greatly increases the range of operation of the car.

The very tough aluminum alloy transmission case is divided into two separate sections, to admit of ease in assembly and to cut down the cost of necessary replacements of parts when long wear has made such replacements necessary. The arrangement of gears is most compact and at the same time simple. If a third shifting fork were employed the case could be made a trifle shorter, but the added complication does not warrant this change. The shaft upon which the gears slide is made cylindrical instead of square, as is the usual practice. With this round fluted shaft it is much easier to obtain perfect alignment with the countershaft while, at the same time, the round shaft is stronger, for equal diameter of gear boss, than a square shaft can be. The gear teeth are made very wide, thus reducing the load per square unit of surface and contributing greatly to the silence and durability of the gears. A very simple interlocking device is employed that makes it impossible to strip gears by trying to shift while the clutch is engaged, and which makes the jumping out of mesh of gears once properly engaged an absolute impossibility.

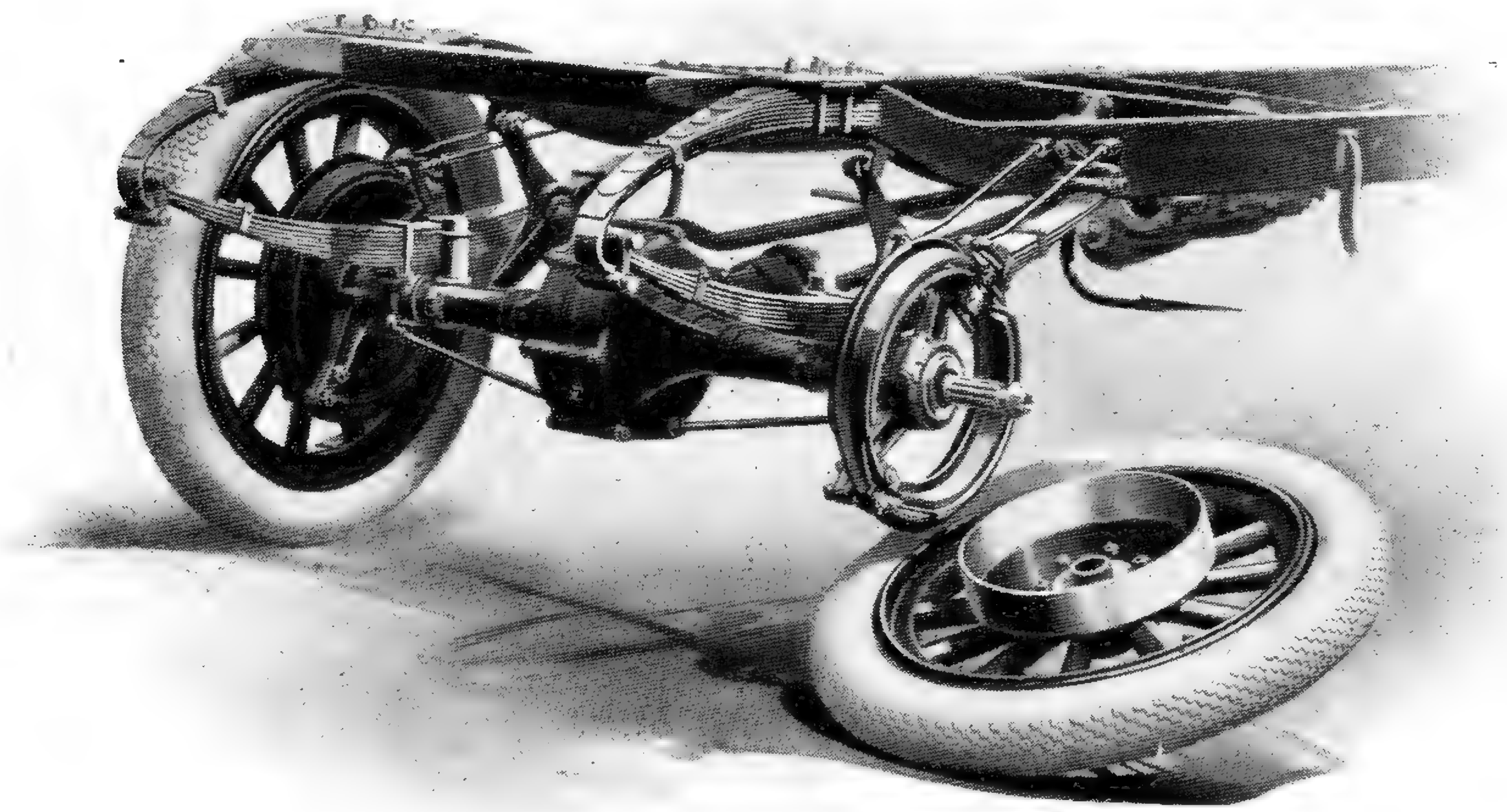
The chrome nickel steel gears used in the transmission are so accurately cut and so carefully handled in heat treating that we are enabled to hold back-lash clearances to a minimum. The limits to which our workmen are held in connection with variations from our standard clearances are, in most cases, less than one one-thousandth of an inch. It is only by obtaining these very careful and accurate fittings that a train of gears can be made silent, and we feel sure that no gears are both as quiet and durable as those placed in the Pierce-Arrow gear boxes.

In connection with alloy steels and heat treatment, a homely comparison

will, perhaps, serve to illustrate the differences that can exist between one set of chrome nickel steel gears and another.

Almost any cook can make bread — of a sort. That is to say, there is no great difficulty in mixing flour, water, salt, yeast, sugar, etc., together into some sort of dough and baking it into some sort of bread. It is a different matter to mix just the right sort of dough and bake it with just the right heat to make really good bread. It is not very hard to make chrome nickel steel, but it requires the greatest care and experience to make it just right and the most minute inspection to make sure that it is just right before using it. Such care costs a great deal of money, more than most "built to price" manufacturers care to spend.

Similarly with heat treatment, there is as much difference between different ways of heat treating steel as there is between the different ways of baking bread, and the right way, the Pierce-Arrow way, requires most minute and painstaking care, and this care, again, costs rather more than many manufacturers can afford to pay.



REAR AXLE

Not only must the rear axle assembly serve as a link in the power chain from motor to rear wheels, but it must, as well, transmit the driving and braking thrust reactions from these wheels to the whole car, absorb the driving and braking torsion reactions and carry more than half of the total car and passenger weight.

The transmission of power from the rear of the gear box to the driving wheels follows through a series of links made up of the front universal joint, propeller shaft, sliding joint, rear universal joint, bevel pinion shaft and bevel pinion, bevel gear, differential gear set, and driving shafts.

Pierce-Arrow universal joints are of the cross-and-yoke type with large hardened nickel steel pins, steel yokes, and bronze bushes of large bearing area. This type has been employed by us for many years with unvarying success. The only wearing parts, the bushes, are easily and cheaply replaced when necessary.

The propeller shaft is of a special alloy steel, very strong and tough and of great elasticity. The rear end is fluted and hollow, the splines sliding in corresponding flutes in the rear universal joint yoke to allow for the movements of the rear springs. This sliding joint is lubricated by means of a charge of grease contained in the hollow end of the shaft. It removes all thrust loads from the propeller shaft and greatly increases its durability.

The bevel pinion shaft is mounted in a housing separate from and securely bolted to the main axle housing. This shaft runs in two very large annular ball bearings, abundantly strong to provide for all radial and thrust reactions from the bevel pinion.

The bevel gears are made of chrome nickel steel. The mounting and assembling of these gears together with the differential set is a matter requiring the greatest care and accuracy if a maximum of durability and silence is to be secured. In our axle assembly department there are a number of special jigs, adjusting, and testing machines, to assist in obtaining this accuracy. In one of these machines the mounted bevel pinion is assembled with the bevel gear, differential, and shafts in such a manner that running conditions and loads are exactly duplicated. In this machine, the adjustment between pinion and gear is made by sound and measured micrometrically to determine the thickness of the various shims used in the final assembly. This machine is both an adjusting and testing implement, and no sets of gears are passed that fail to satisfy the most exacting demands of silence.

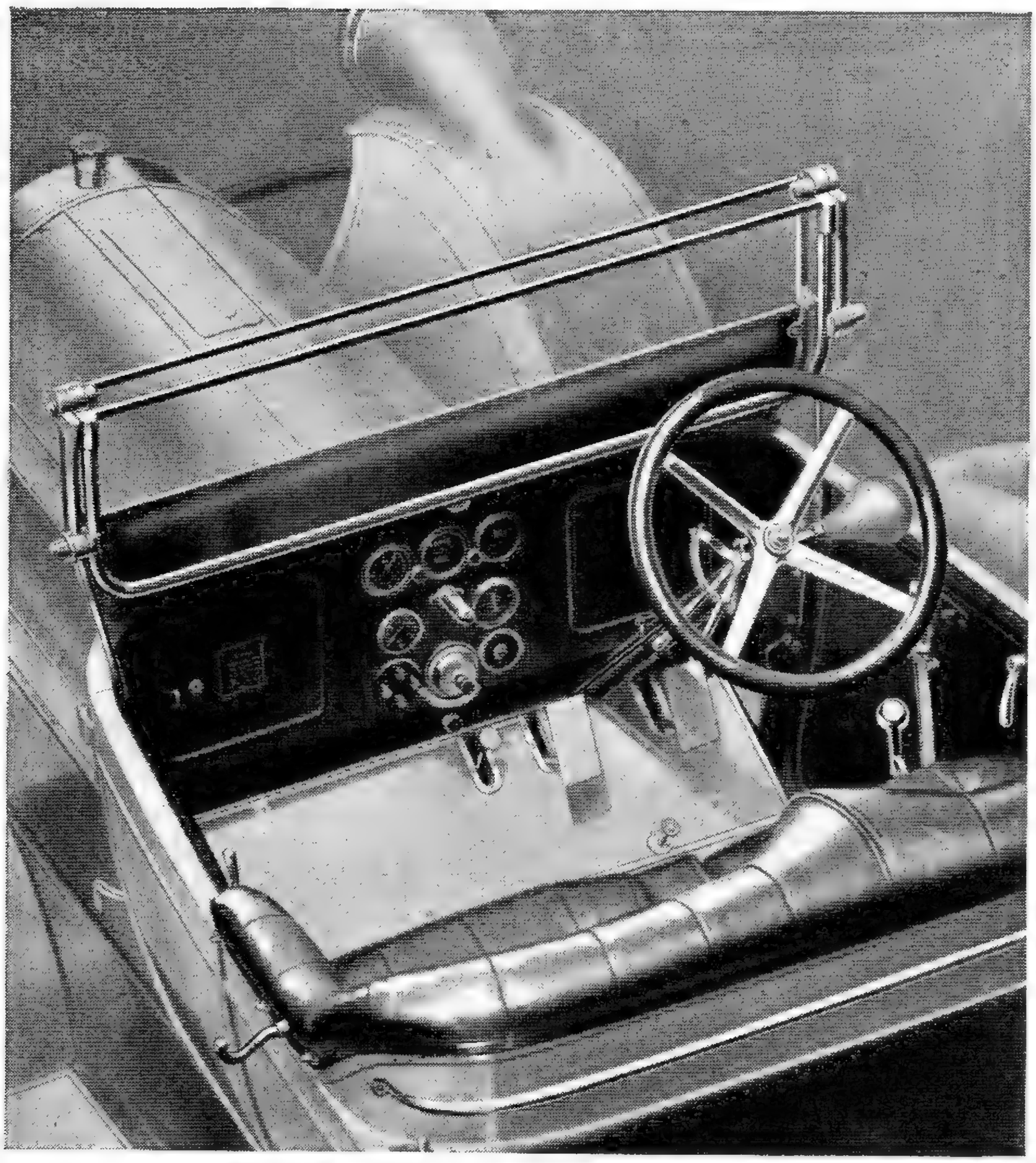
The semi-floating, imported chrome nickel steel axle shafts are heat treated to obtain the maximum of strength with due regard to ductility, and given their final cut to size by grinding instead of turning, as is the usual practice. It has been found that finishing in this manner considerably increases the strength of these shafts.

The fundamental difference between semi-floating and full-floating lies simply in the manner in which the weight of the car is supported. In the full-floating type the load is carried directly by the housing, while in the semi-floating type the load is transmitted first to the driving shafts and from them to the housing. In either case the axle can be made amply strong to carry the load in a thoroughly efficient and durable manner. The selection of one type or the other becomes, therefore, simply a matter of design — a choice as to which form, in the opinion of the designer, will give the desired result with the least weight, the least danger of inaccuracy of manufacture, and the least complication.

The Pierce-Arrow designers became convinced many years ago that the semi-floating type, designed and constructed in the Pierce-Arrow way, fulfills these conditions of minimum weight, minimum danger of inaccuracy, and minimum complication in a most efficient manner.

Semi-floating shafts, being removable without disassembling the axle housings, contribute greatly toward the low cost of necessary repairs and inspections. They also enable surplus oil and grease to be readily cleaned from the housing tubes, a fact that is greatly appreciated by drivers and repair men.

The tubes encasing the driving shafts are made of nickel steel, brazed and riveted into the steel housings enclosing the bevel gear and differential assembly. This method insures a very rigid and absolutely safe construction, while, at the same time, being both compact and very light.



STEERING AND DRIVING POSITION

EASE in directing the course of a fast-moving vehicle — for the comparatively weak woman as well as the strong man — the minimum of fatigue during the last few miles of a long day's run, protection of steering rods from road obstructions, and easy and natural access to the emergency brake and gear levers, are some of the absolutely essential qualities that must be realized in designing the steering and control arrangements and driving position of a touring car, in order that maximum safety to the occupants may be secured.

Not only must the initial safety in a new car be considered, but all parts must be so designed and constructed that their durability will constitute a permanent insurance against accident during the whole life of the car.

We believe that the control and steering arrangements and position, from the point of view of both design and material, employed in Pierce-Arrow cars fulfill these imperative requirements in the most efficient manner.

The steering gear itself is of the multiple screw-and-nut type and is so geared as to give a ratio of $1\frac{1}{2}$ to 1 in favor of the driver. The semi-irreversible nature of this type of steering gear, coupled with the low ratio and large steering wheel,

eliminates all danger from sharp changes of direction due to road shocks or the danger from having the wheel torn from the driver's grasp. While sufficiently irreversible to insure against danger from shock, this type of gearing is flexible enough to enable the operator to follow very easily the smooth sections of the road and to give the steering wheel that live responsiveness which contributes so much to enhance the pleasure and reduce the fatigue of driving.

The usual worm-and-wheel type of steering gear has but one real point in its favor compared to the screw-and-nut type. This point is one of cost, both in manufacture and fitting. Instead of the approximately six square inches of bearing surface in the screw-and-nut type, the worm and wheel has but a line bearing, which, when the elasticity of metals and lubricating film are considered, give a bearing area of only approximately one-quarter of one inch. These relative bearing areas are directly in proportion to the relative durability of the two types.

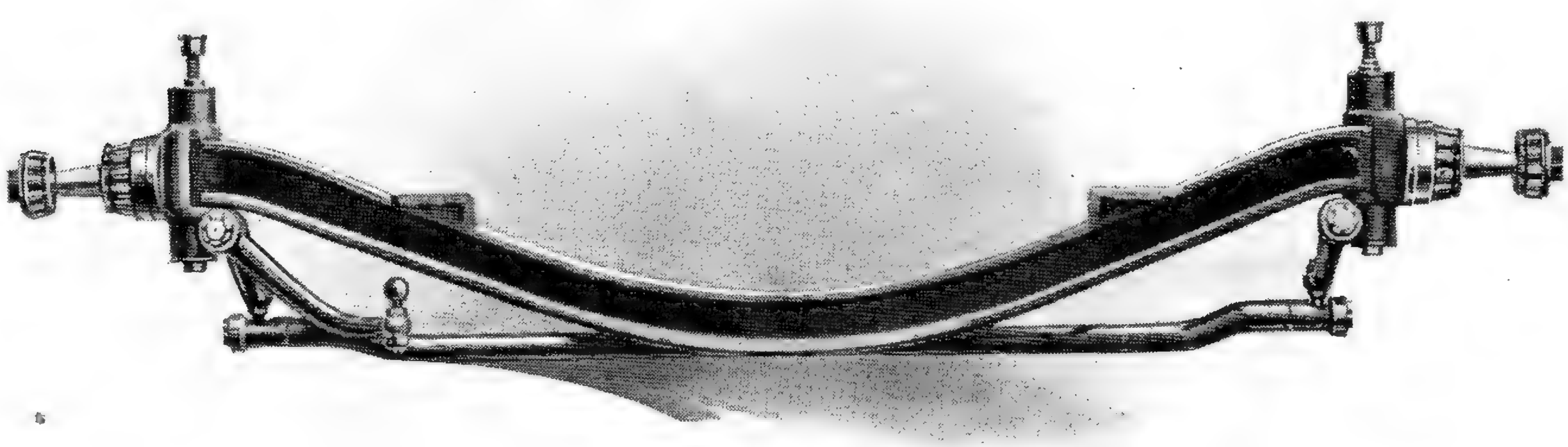
The screw-and-nut type of gearing is remarkably free from vibration, which, when transmitted to the steering wheel, does more to fatigue the conductor than any other driving factor.

The extreme durability of this type of gearing is manifested by the fact that frequently no adjustments or renewals of the nut and worm are necessary even after four or five years of constant running.

The steering coupling rod connecting the two front wheels is located behind the front axle, ensuring its protection from blows that might seriously endanger the control of the car.

The type of ball and spring socket knuckle joint used is another example of careful design and construction which eliminates vibration, contributes to safety, and insures a minimum of fatigue to the driver.

The emergency brake and gear-shafting levers are placed within easy reach of the operator's right hand, where he will automatically look for them at times when quick action becomes a matter of the utmost significance.



Front Axle

SUSPENSION

THE protection of the mechanism and passengers of a motor car from road shocks is one of the most difficult and complicated problems that automobile engineers have been called upon to solve.

Interposed between the road inequalities and the passenger are a series of cushions made up of the tire, the car springs, the shock absorbers — to control the rebound of the springs and tires — and the springs in the seat cushions.

There are so many different types of car springs and so-called shock absorbers that it will be well, before considering these, to give some idea of the various functions they are required to perform.

It must be constantly remembered that road inequalities need not, and seldom do, occur equally upon both sides of a car. One wheel may fall into a hole at the same time that another wheel mounts an obstruction. The four points of contact of a car with the road are seldom in the same plane and the resulting "weaving" of the car must be so taken care of by the springs that the frame of the car will remain as closely and constantly in a horizontal plane as possible.

If the springs be too light, when a wheel drops into a hole the corner of the car frame supported by that wheel will follow. If the spring be sufficiently stiff, it will act quickly, and by following up the wheel will hold the corner of the frame at a constant level. If, on the other hand, the spring be too strong, when the wheel mounts a sudden obstruction it will not compress rapidly enough under the shock to prevent the frame corner from rising with the wheel.

So far as the direct action of the springs is considered, it will be seen that, if all road shocks were of equal intensity, it would be comparatively an easy matter to absorb all such shocks so efficiently that the parallel level of the frame, in relation to the average plane in which lie the four points of contact with the ground, could be readily maintained. Road shocks, however, are of very varying degrees of intensity and each action of a spring has its equal and counterbalancing reaction.

The simile of the boy's "sling-shot" is a very good one to use in making clear this spring reaction. The boy exerts a certain force, gradually, in extending the rubber bands of his weapon. This force is stored up in the bands, and being released, suddenly, is concentrated upon the missile, which is thrown to a considerable distance.

Automobile spring action and reaction, to be effective, must be the direct opposite. The road shock causes a rapid compression of the springs, storing up a considerable amount of force in their leaves, which must be so released as not to suddenly and abruptly alter the level of that corner of the frame supported by the spring.

The pneumatic tire serves to entirely absorb numerous very small shocks.

As the shocks become greater, the springs come into action. As road shocks vary in intensity so must the spring action vary in intensity, and the springs must be designed to operate in a progressive manner.

It is for this reason that a large number of leaves are used in a car spring. The long and comparatively flat leaves absorb the lighter shocks, and as these shocks increase in intensity, one after another, the shorter and stiffer leaves come into play.

While the relative and progressive stiffness of springs governs their ability to absorb sudden shock, the relative weights and corresponding inertias of the portions of the car above and below the springs play a most important part in the manner in which these absorbed shocks are given up.

Most car users recognize that their cars ride easier when fully loaded than when empty, but not many of them realize why this is the case.

The explanation is very simple.

After a car spring has been compressed in receiving and absorbing a road shock, it has an immediate tendency to return to its original form. In doing so, it gives up the energy stored up in absorbing the shock. If, in the case of a rear spring, the axle and wheel be very heavy and the body very light, the spring, in reacting, will throw off the body more rapidly than it will the axle and wheel. The heavier the body and its load in relation to the axle, or the lighter the axle in relation to the body and its load, the less will be the effect from the spring reaction noticeable to the passengers in the car.

This is one of the main reasons for not mounting the gear box integral with the rear axle. When so mounted, it decreases the inertia of the body and increases the inertia of the axle in the same proportion. In other words, the transference of this unit from above the springs to below them causes a relative decrease in the efficiency of the springs proportional to twice the weight of the unit transferred.

The function of a so-called "shock absorber" is to restrain or "dampen" the reaction or rebound of a compressed spring. It serves to enable the compressed spring to give up a portion of its stored energy in the form of heat, which is engendered through the medium of the friction in the "shock absorber." The springs themselves are, in reality, the shock absorbers, while the devices that bear that name might, perhaps, better be known as "reaction dampeners."

Due to the confusion of ideas in this connection, there are two distinct types of devices on the market, both of which are known as "shock absorbers." One of these types is the set of small spiral auxiliary springs used, in many forms, to take up minor road shocks. The other type is the true dampener, such as used on all Pierce-Arrow cars, the function of which is purely to dampen the effects of spring reactions.

While this second type is of a very distinct value, the first type is useful only

when applied to a car whose springs are not appropriately designed to bear the load imposed.

There are five principal types of motor car springs. These are the semi-elliptic, three-quarter elliptic, full elliptic, platform, and cantilever springs.

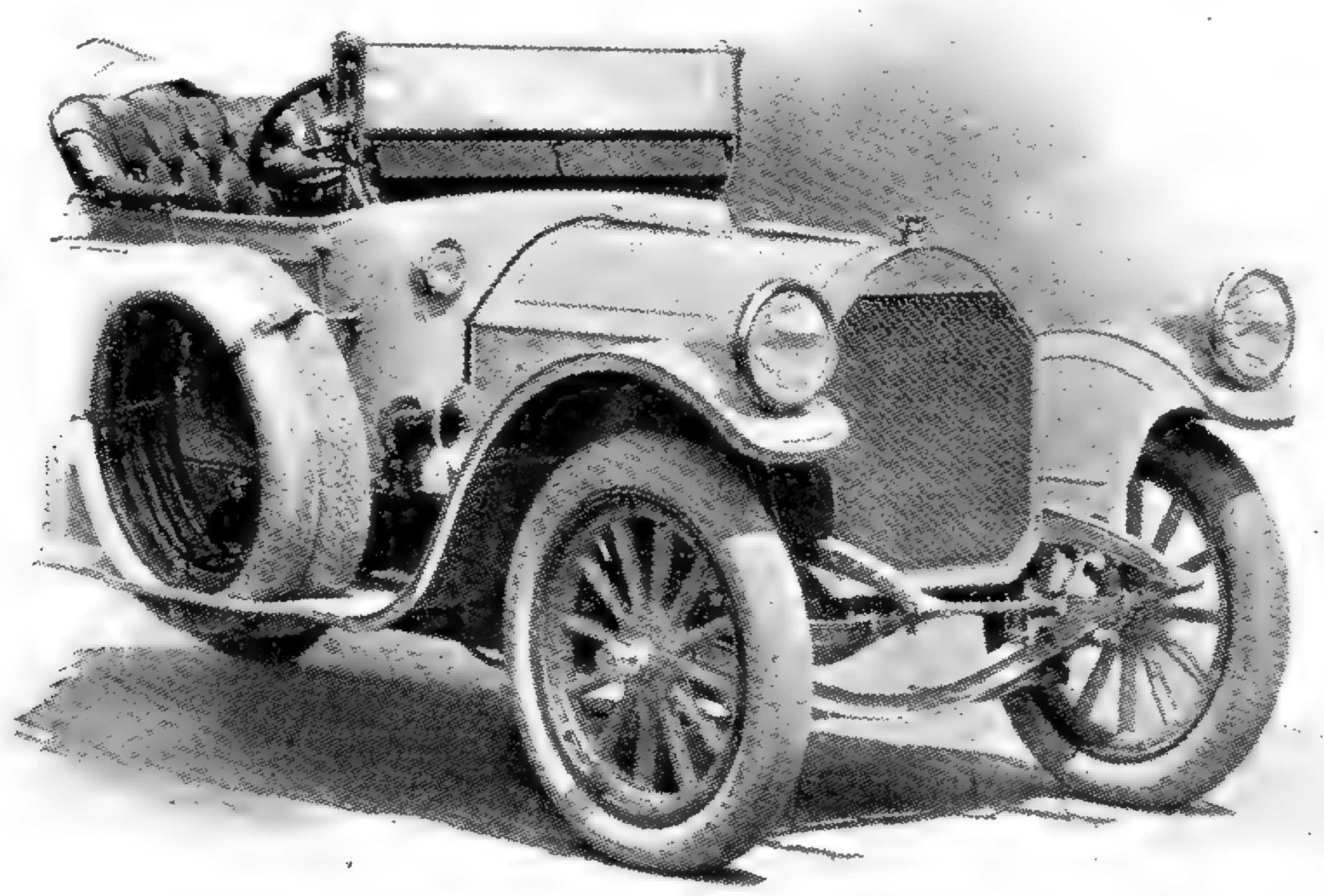
Ninety-five per cent. of the larger motor cars exhibited in recent United States automobile shows were equipped with semi-elliptic front springs. The other 5% used the full elliptic type.

Sixty-eight per cent. of these cars were equipped with three-quarter elliptic rear springs, 14% with full elliptic, 12% with half elliptic, and 6% with platform springs.

The cantilever type is used by but one or two cars of foreign manufacture and of peculiar design. The principal exponent of this type is the Lanchester, an English car, which is so designed that the driver sits beside the motor. This arrangement makes the cantilever desirable, in order to give a long wheelbase with the comparatively short body suspended well between the wheels.

Pierce-Arrow front springs are semi-elliptic with the right spring made slightly stronger to provide for the torque reaction from the motor. The chief disadvantage of the full elliptic spring in this position is its lack of lateral stability, which is of vital importance, both from the point of view of maintaining the average level of the car frame and that of minimum disturbance to the steering control.

Pierce-Arrow rear springs are three-quarter elliptic, giving the maximum of spring action in the position consistent with lateral stability and flexible power transmission from the driving wheels to the frame. In addition to the lateral instability of the full elliptic rear spring, it is necessary to use radius rods when this type is employed at the rear of a car, to transmit the driving reaction from the rear wheels to the frame. These radius rods, in addition to adding weight and complication of wearing parts, serve also to make the drive to a certain extent brutal in its action. When the drive is through the springs, a degree of flexibility results that contributes largely to the comfort of the passenger.



BRAKES

THERE are several ways to stop a motor car traveling at speed. One way is to run it into a good stout stone wall. Though unquestionably efficient, this method is commonly objected to as being wasteful and over dangerous.

Some brakes, while not quite so radical, are sufficiently wasteful and dangerous in their action to be likened to the stone wall.

It sometimes happens that, to save life, the stone wall method is the best. It is occasionally desirable to apply brakes sufficiently brutally to lock the wheels. As a general practice, however, there is little to choose between the two from the point of view of damage to the pocketbook of the car owner.

It is a scientific axiom that energy is indestructible. It may be inactive, as is, for instance, the energy stored in a ton of coal or gallon of gasoline. It may be active as in the case of steam acting against a piston head. It is further true that as soon as energy becomes active, it begins to change its visible form of manifestation. In most of the mechanical manifestations of energy this change is in one of two directions: either from heat to motion or from motion to heat.

The forward movement of a motor car is an example of the translation of energy from heat into motion, and the stopping of the car is an example of energy translation from motion back again into heat.

A simple example of this translation from motion into heat is witnessed when a piece of metal is struck a number of blows with a hammer. The motion of the hammer head is arrested by the impact with the metal and the temperature of both hammer head and metal is very sensibly raised.

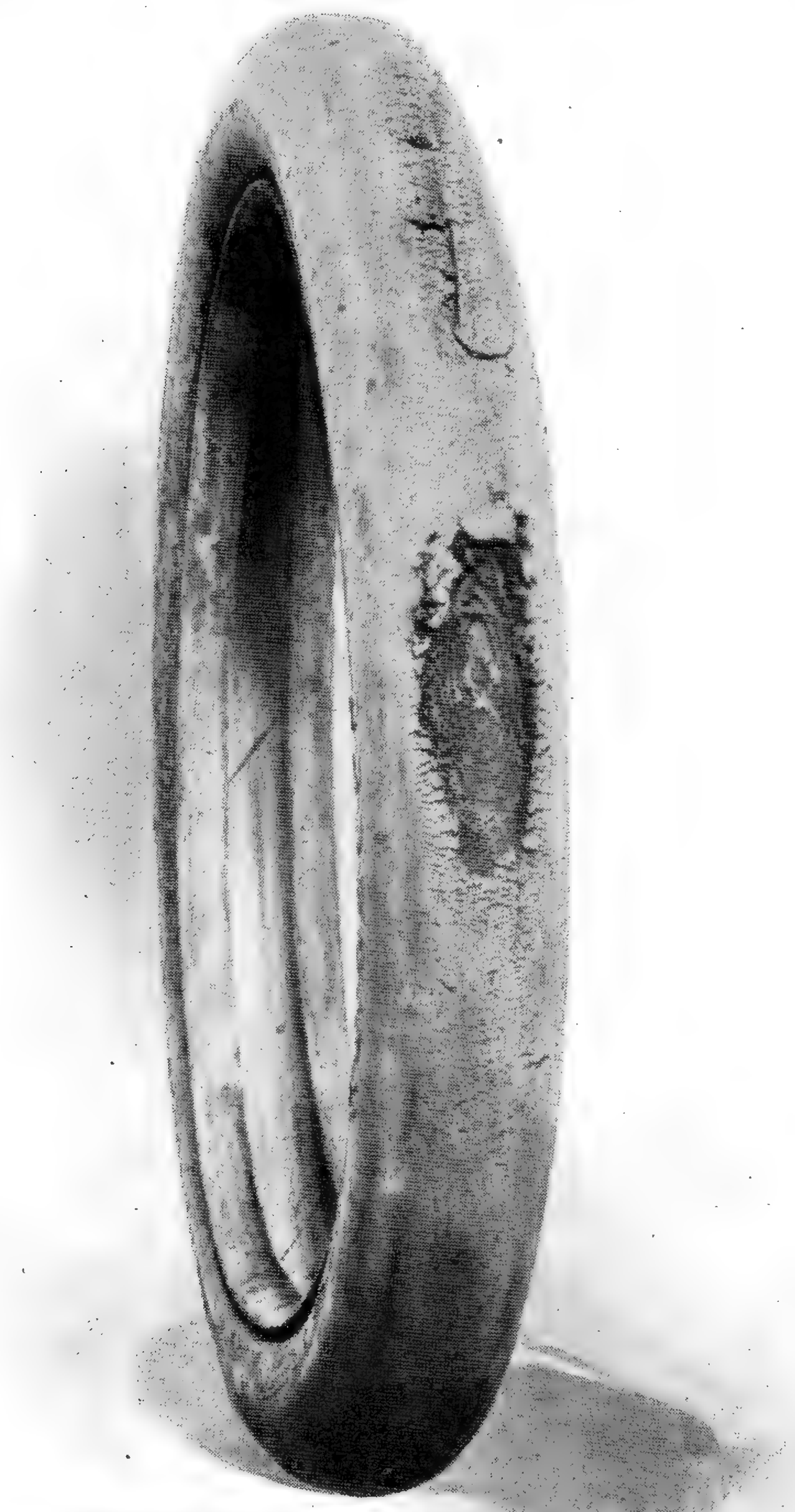
Motor-car brakes are the medium through which the motion of a car is translated into heat. To be truly efficient, they must perform their function with the minimum of wear on the tires and mechanism of the car and with the minimum of shock to the passengers. They must do this with the maximum of celerity.

Brakes may be considered as a friction machine for generating and radiating heat. It will be easily understood that the moment motor-car wheels become locked, friction between brake shoes and drums ceases, and the whole work of heat generation is transferred to those portions of the tires in contact with the road and the road itself. The destructive effect upon the tires of this concentrated friction may be readily imagined and, particularly so, when it is realized that the heat generated has a very marked softening effect upon the rubber.

Pierce-Arrow brake shoes and drums are made very large so that the frictional wear may be distributed over a large surface and the generated heat quickly radiated. In addition to large radiating surfaces, it is desirable that a considerable body of metal be in contact with the brake liners to draw the heat away from the friction surfaces by means of induction.

One of the chief disadvantages of a thin band brake is this lack of body. An inch of water in the bottom of a vessel will come to a boil just twice as quickly as two inches. The thin band brake will heat up much more rapidly than a comparatively heavy brake such as used on Pierce-Arrow cars.

Pierce-Arrow brake shoe linings are of such materials that considerable pressure must be exerted before the wheels lock. In case of emergency, the wheels can be locked, but they are not likely to lock under ordinary circumstances. It is extremely difficult to prevent some designs of brakes from locking the wheels. The range of pressure between "free" and "locked" is too short; durability, flexibility, and the owner's pocketbook are sacrificed to brutality, lightness and low cost.



Locked Brakes!

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Pierce-Arrow Frame

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Pierce-Arrow Frame

BODY DESIGN AND CONSTRUCTION

We do not believe there is another car showing the same Unity of Design as the Pierce-Arrow. Our constant aim is and has been to produce a distinctive type of vehicle. This policy, followed throughout many years, has finally resulted in a complete change of construction and design. Wood and sheet aluminum have given way to cast aluminum; details and accessories once thought indispensable have disappeared, and those remaining have been submerged into and become an integral part of the whole.

There is an old maxim which says: "Construct first and decorate afterwards." This has been followed literally in the Pierce-Arrow. The underlying feature at every point is sound construction.

The disadvantages of wood and sheet metal as body materials were early realized by the Pierce-Arrow Motor Car Company, and, after exhaustive experiment, they selected cast aluminum as being far preferable.

In order to make bodies that would not be inordinately heavy it was necessary to make the variously curved castings for the different sections not of a uniform minimum thickness, but of a varying minimum thickness. To provide extra material at points where extra strains occur, to cut down the thickness of the metal to a practical minimum where the strains are slight, and to make the finishing surface of absolutely perfect curvature and finish, were some of the foundry problems that had to be met.

The building of the wooden patterns from which such castings are made has become an art closely related to that of sculpture. The body contour is literally carved out of narrow strips of wood glued together, which have been previously roughly sawed to templates.

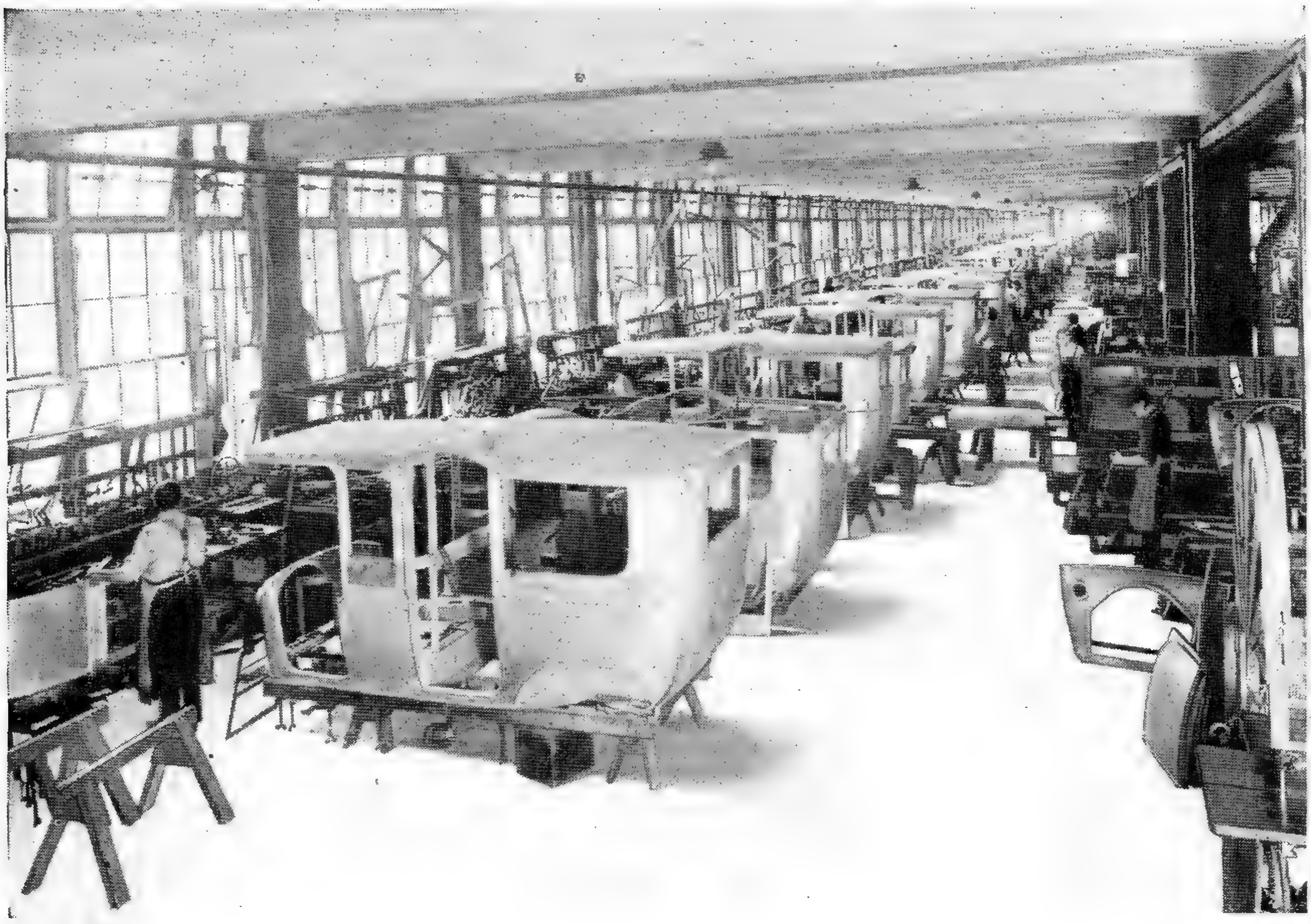
When these carefully proportioned castings are delivered from the foundry, they are rigidly inspected for flaws or air holes, and weighed to make sure they contain no more metal than necessary.

After weighing and inspection, the work of finishing the surface begins in the Filing and Scraping Department. Upon the texture of this finish depends the excellence and durability of the painting.

After surfacing, the sections are riveted together, and so well and carefully is this work done that only a most minute inspection can discover where the jointures are made even before a single coat of paint is applied.

After the joining is completed, the shell is sent to the wood-workers to receive its backing of selected ash.

The careful proportioning of the thickness of the various cast sections makes it unnecessary to go to anything like the extremes of bracing and backing that become necessary where sheet metal is used. It is in the great reduction of the amount of necessary bracing that we are able to save weight



Body Shop

and make our cast bodies lighter for equal strength than any sheet body can be built.

In a few instances and on special bodies of other than standard design, where there was no probability of the design being repeated, sheet aluminum has been used to avoid the prohibitive cost of special patterns and moulds. Our experience along these lines has taught us that well-built and equally strong sheet metal bodies have absolutely no advantage over cast bodies, such as we build for our standard cars, no matter from what point of view they may be considered.

To the body builder who endeavors to satisfy the cravings of each customer for particular curves, quirks, and mouldings, the cost of cast bodies would be prohibitive in spite of the fact that, when built in reasonably large numbers, they cost actually less than the equally strong and considerably heavier, adequately braced sheet metal designs.

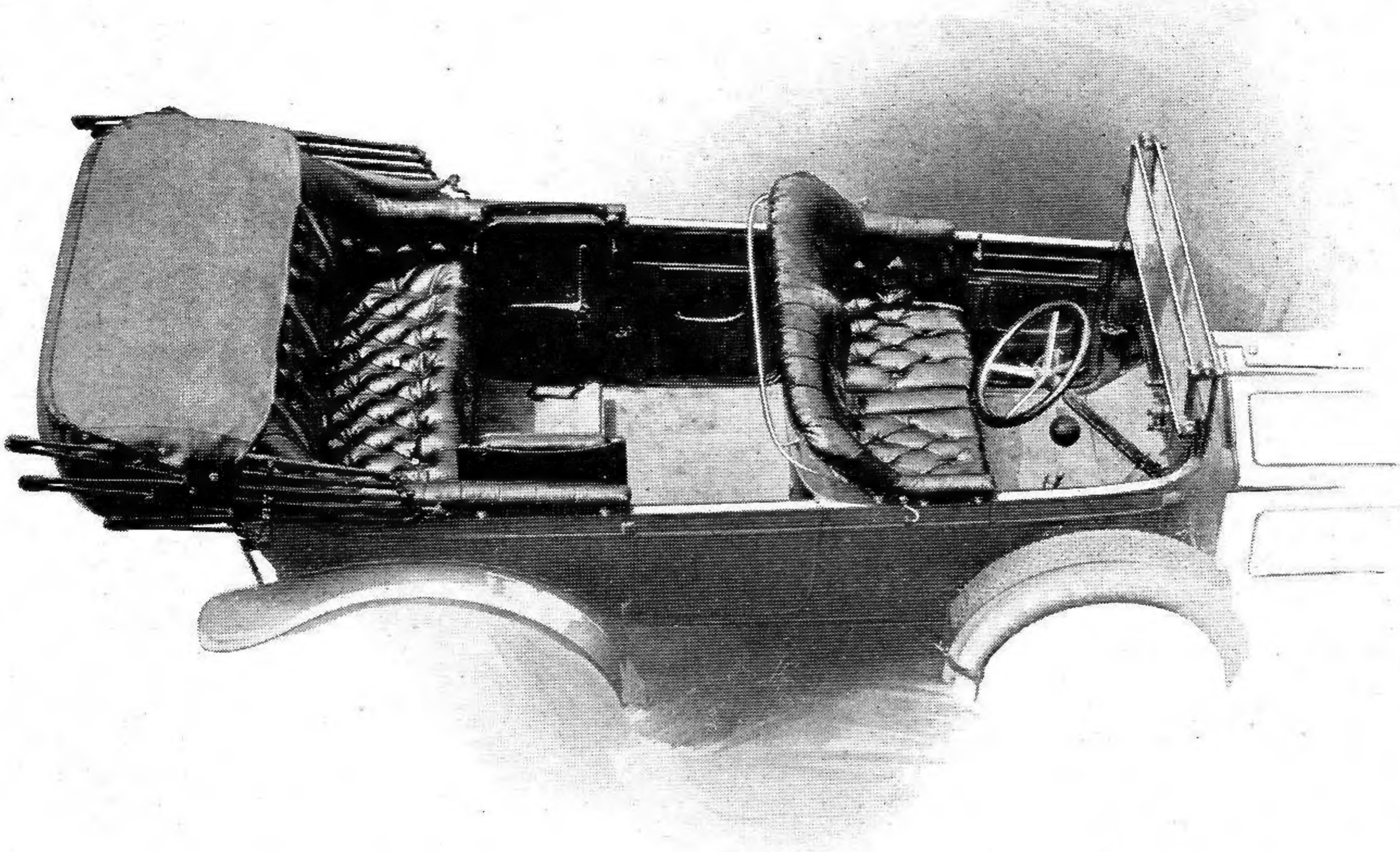
Pierce-Arrow bodies, such as we are now able to build after many years of experience and development, are lighter than a serviceable sheet metal body can be made. Being rigid, they do not drum from vibration nor warp or buckle from extreme changes of temperature. Their rigidity is also a great protection to the finish, as the best applied and selected paint is not elastic enough to remain uncracked if the surface to which it is applied be bent or distorted. Very slight pressure on a sheet metal panel will leave a most unsightly depres-

sion that it is impossible to remove without destroying the finish. It is extremely difficult and expensive to build round corners in sheet metal, while it is a perfectly simple matter to accomplish this with a casting. Mouldings are an integral part of Pierce-Arrow bodies. On sheet metal bodies, mouldings must be fastened on, and are liable to come loose.

It has often been stated that cast aluminum cannot be satisfactorily repaired. While this used to be the case it is no longer true. In the last few years welding processes have been perfected that enable this metal to be patched and repaired as easily and perfectly as a sculptor works his modeling wax.

Apart from durability and finish, Pierce-Arrow cast bodies have so much sturdiness that they serve as a very real insurance to the occupants of a car in case of an accident, where the wood body would splinter most dangerously, perhaps catch fire, and a sheet-metal construction crumple or collapse.

A customer buying a Pierce-Arrow body is taking no chances. In the first place, he is getting a body that he can depend upon. It will not rattle to pieces in a short while, is second to none in construction and design, and on account of its sturdiness may be the means of preventing injury in case of possible accident.



Posted on: January 25, 2020

Edited by: Brian D. Szafranski
Elma New York USA

THE
MATTHEWS-NORTHRUP
WORKS
BUFFALO CLEVELAND AND NEW YORK

THE COMPLETE
PRESS